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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Paris Convention.

On our return from participation in the Fourth International Foundry Congress, held in Paris last week, we could not help thinking that there are too many of these manifestations. The exhibition disclosed but few new developments—certainly insufficient to warrant an extended absence from business, whilst the Papers presented were of a high standard. The works visits were interesting, and even though some of us had had the privilege of visiting these foundries on previous occasions, there were to be seen a number of new departures, associated with more intensive mechanisation. The British delegation, headed by Mr. Andrew Harley, Immediate Past-President of the Institute of British Foundrymen, and President of the Foundrymen's International Technical Committee, was probably the largest, though the Italian, Belgian and Spanish were also important. There would be about thirty-five Britishers present; American participation, however, was limited to Mr. MacPherran and Mr. Zeman. A feature of the Congress was the support accorded to it by the French Government, and the delegates were honoured by being received last Sunday by the President of the Republic. Mr. Ronceray, the President, had certainly arranged for his guests a strenuous programme. Cars for the works visits left or were scheduled to leave at 8 o'clock in the morning, whilst but little time was given for dressing for dinner; this factor was not too important, as starting times are always a little elastic in France.

A feature very much appreciated by the visitors was the film showing the manufacturing organisation of the Paris-Orleans Railway Company. The social programme, including that designed for the entertainment of the ladies, was well planned and splendidly executed. We wish to associate ourselves with Mr. Harley, who spoke for all the nations at the closing banquet, in voicing the appreciation of the visitors for all that had been afforded them. At a meeting of the International Technical Committee, Mr. Maas Geesteranus, of Holland, was elected President and Dr. Pisek, of Czecho-Slovakia, Vice-President. It was announced that the next international conference would take place in Prague in September of next year.

It must be confessed that the spice of novelty of international foundry gatherings no longer exists, but there is now established a number of activities of a progressive character which must be maintained at all costs. The business aspect of these gatherings now eclipses any notions of "joy trips." The foundry world is co-operating for the solution of innumerable problems, and Paris has set a standard which must be maintained at all future gatherings. Its organisers aimed at elucidating problems of testing, of technological translation, of the interchange of students. These are but a few of the subjects which can only be solved by international co-operation, and once again we express our indebtedness to our hosts for their helpful leadership.

The Winter Programme.

Various technical societies and institutions have been busy preparing their programmes for the forthcoming winter session, and in particular the various branches of the Institute of British Foundrymen are looking forward to heavy programmes of lectures and visits.

We venture to remind the secretaries and officers of the various branches of one or two points which will materially contribute to the success of the season. When a lecturer is expected from a distance we suggest that mere courtesy requires that he should be met at the station and conducted to the lecture hall, preferably by the President, and, failing that, by other members of the Council. We would suggest that the branch officers and other members of the Council have in this respect an opportunity of relieving the usually overworked secretary; he is generally busy attending to such points as making sure of the successful operation of the lantern, etc.

We believe that the success of an evening meeting depends to some extent on a prompt start, a very brief introduction by the chairman and a discussion which closes leaving just a little more to be said. It is to the good of the Institute, and of the industry, that as far as possible members who, either from youth or from inexperience, are not in the habit of contributing to discussions should be encouraged in every possible way to do so, and thus make it less necessary for the more fluent members, or the old guard, to fill in the gap.

Some secretaries make a point of balancing the programme in order to have something appealing to all tastes—technical and practical, ferrous and non-ferrous, and so on. It is also a good plan to have some meetings taken by members of the branch themselves, either singly or in the form of a series of short Papers, or symposium, on one subject, or on a variety of subjects. If this is done no one can feel any cause for complaint that his particular interests receive inadequate attention.

Foundrymen's International Technical Committee.

At a meeting held at the Ecole Supérieur de Fonderie, Paris, last Saturday, under the Presidency of Mr. A. Harley, there were nine nations represented. Mr. A. Damour, the retiring President; Mr. Ronceray, President of the Association Technique de Fonderie, and Mr. Koehler acted for France; Mr. V. C. Faulkner and Mr. J. Cameron, Great Britain; Dr. Geilenkirchen, Germany; Mr. J. Leonard and Mr. R. Deprez, Belgium; Mr. V. Delport, America; Mr. J. M. España, Spain; Dr. Guido Vanzetti and Commendatore Jarrach, Italy; Dr. Pisek and E. Rynda, Czecho-Slovakia; and Mr. Z. Lenartowicz, Poland. Apologies for absence were received from Mr. Maas Geesteranus, the Dutch Vice-President; Mr. Paul Ropsy, the first President; and Dr. Humperdinck, who represents Germany, and who unfortunately is very ill.

After Mr. Makemson had read the minutes of the last meeting, held in Milan, the Committee made recommendations as to the presentation of "Exchange Papers," the training of students in countries other than their own, and the creation of an international dictionary of foundry terms. Dr. Pisek, the President of the Czecho-Slovakian Foundrymen's Association, then issued a very cordial invitation to the Associations represented around the table to participate in an international conference to be held at Prague from September 9 to 17 next year. We detail below the tentative programme which has been arranged. The Papers to be presented will be available in the language of their authors, and a synopsis made in English, French and German.

Mr. Maas Geesteranus was elected President for 1933 and Dr. Pisek the Vice-President.

INTERNATIONAL FOUNDRY CONGRESS, Prague, September 9 to 17, 1933.

The Congress will be held under auspices of the Ceskoslovensky odborny spolek slevárensky (Czecho-Slovak Foundry Association).

PROPOSED PROGRAMME.

Saturday, September 9.—Arrival of delegates in Prague. Registration, issue of membership cards, accommodation, etc. Dinner at 8 p.m.

Sunday, September 10.—10 a.m.: Official opening of the Congress. Sessions of the Congress and presentation of Papers.

Afternoon: Sightseeing tour through the city and visit in groups to places of interest in the neighbourhood of Prague (Karluv Tyn, Melník, Podebrady).

5 p.m.: Reception by the Mayor of Prague.

Monday, September 11.—Morning: Visit to foundries and factories in Prague.

Afternoon: From Prague to Moravská Ostrava by train.

Evening: Dinner in Moravská Ostrava.

Tuesday, September 12.—Morning: Visit to Vítkovické zelezárny (iron and steel works), Witzkowitz (Vítkovice).

Afternoon: Visit to coke plants at "Frantisek" and "Ignat" pits, and visit to mines.

Wednesday, September 13.—Morning, Group I: Visit to iron and steel works of the Bánská a hutní spolecnost (mining and iron company) in Trinec.

Afternoon: Return to Moravská Ostrava.

Morning, Group II: From Moravská Ostrava by train to Zlin. Visit to the Bata shoe factories.

Afternoon: Leave Zlin for Brunn (Brno).

Thursday, September 14.—Morning, Group I: From Moravská Ostrava by train via Prague to Pilsen (Plzen).

Morning, Group II: Visit to foundries in Brunn.

Afternoon: Leave Brunn for Plzen.

Friday, September 15.—8 a.m.: Visit to foundry and steel plant of the Skoda Works in Plzen.

Afternoon: Visit to the Mest'ansky pivovar (Citizens' Brewery) in Plzen.

Saturday, September 16.—Morning: Visit to kaolin pits and West Bohemian kaolin and refractories plant at Horní Bríza.

10 a.m.: Closing banquet.

Sunday, September 17.—Departure of the delegates. Arrangements can be made for trips to the famous Bohemian watering places, such as Karlovy Vary, Mariánské Lázne, Jáchymov.

District Presidents.—No. 6.

LONDON BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN.

Mr. H. G. Sommerfield, President of the London Branch of the Institute, was initially destined for the Civil Service, but after some six years he entered the foundry industry and since 1910 has always been greatly interested in all its branches. He has travelled extensively and is a recognised authority on Scandinavian foundry practice. He joined the Institute in 1914

MR. H. G. SOMMERFIELD

(Chairman of the London Branch of the Institute of British Foundrymen).

and during the war served as an officer in the Royal Artillery.

Mr. Sommerfield occupied the position of Secretary to the London Branch for eight years, during which period two international conferences were successfully organised, whilst he is a Vice-President of the Foundry Trades' Equipment and Supplies Association. He always has taken great interest in municipal work, and has served as Chairman of the Finance Council for the past five years, besides holding important positions on many educational bodies.

Mr. Sommerfield is head of the firm bearing his name, and is a Freeman and Liveryman of the City of London.

United States Steel Corporation.—According to a cable from New York, unfulfilled orders of the U.S. Steel Corporation on August 31 totalled 1,969,595 tons, an increase of 3,293 tons. This is the first increase to be shown for 17 months, and is in accordance with conservative estimates. The increase is generally considered encouraging, and it is widely believed that a larger improvement will be shown in the September steel figures.

Random Shots.

Last week the British official gazette must have published a special supplement, as every foundryman who visited Paris found himself knighted. The Lancastrians, the Funf Club and other unofficial foundry associations will have to look to their laurels, as their status will soon become *non locus standi* compared with the new creation, "Knights of Foundry Industry." Sir Harley has been elected president, whilst the obvious choice for the secretary was Sir Makemson. A ladies' section, too, is to be formed—the dame president is Mrs. Harley, Esq., with Miss Helen Pearce, Esq., as vice-chairman.

* * *

The railway companies of Great Britain were well represented in Paris. Headed by Sir Henry Fowler (he is definitely not eligible for membership to the new "Knights of the Foundry Industry Club"), the delegation included Mr. Millington, Mr. Turbot and Mr. Hargreaves, and the interest they took in the manufacture of automobiles clearly showed they were having a busman's holiday.

* * *

Nothing impressed the British so much as the absence of French in French foundries. The personnel seems to be made up of French foremen, charge-hands and highly-skilled workmen, female crane drivers, and an anomalous collection of Arabs, Gyppos, Sidis and what-nots, ranging in colour from deep black to light brown. There are about 5,000,000 foreigners in France, so any unemployment problem can easily be solved by asking a few hundred thousand what-nots to return to their wigwams, igloos and kraals.

* * *

Owing to the rate of exchange none of the British visitors reserved rooms in the exclusive Hotel de Ville, several, however, climbed to dizzy heights of Montmartre, Montparnasse and the Mont de Piété. They left their hearts at the first, cent francs in the second and their watch in the third. Alas! Paris is not what it was! In place of a champagne or oyster cocktail, the *petites femmes* of Olympia now demand a "bock," and accept without question the third refusal.

* * *

The National Museum of Wales, "Marksman" notes, has selected as its special exhibit this week a rather remarkable specimen of the art of the early bell founders. The bell is of cast bronze and dates back, it is thought, to the 10th century. The loop handle is cast in one piece with the bell itself, and terminates in animals' heads. It is, in fact, the only one of the eight now known in Wales and the Marches to have an ornamented handle.

* * *

The following appeal, so "Marksman" is given to understand, appeared in the Appointments Wanted column of a weekly technical journal. It is reproduced without comment: "Stoker, 36, abstainer, married, desires change."

* * *

There is a story about a Scotsman whose daughter was being married and, as the bride and groom were about to leave the house, Sandy insisted that they should leave by the back door instead of the front.

"Whist, Sandy," whispered his wife, "are ye clean daffy?"

"Hush, woman," he replied. "If there should be any rice throwin', I thought it would be verra, verra nice for the chickens."

"MARKSMAN."

Fusion Welding as Related to Steel Castings.

By T. S. Quinn.

(*Continued from page* 164.)

Data from Tests made under Author's Direction.

Many experiments have been conducted at the plant of the Lebanon Steel Foundry and elsewhere for this plant, extending over a period of several years, to ascertain the kinds of equipment, supplies, voltages, amperages, gas pressures, etc., to employ selectively for most effectively welding steel castings of widely-varied compositions.

A few of the results obtained at the foundry mentioned are indicated below; not, however, with the claim that they represent, in any instance, the most effective welding capable of being done with the material in hand, but with the hope that they may be helpfully suggestive. Limitations of space left after reporting results secured in other plants and laboratories, prevent

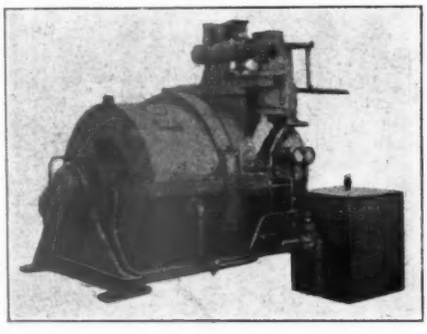

FIG. 1.—STEAM TURBINE HAVING STEEL CASTINGS WELDED TO ROLLED-STEEL PARTS.

elaboration on the tests made in the foundry with which the author is connected.

Tests of Cast Steel Welded by the Arc Method.

Report No. 16. *Tensile Tests on Welded Bars.*—Coated welding rod contained C 0.13, Mn 0.46 and Si 0.04 per cent., no special alloys being found on analysis. The chemical composition of the bars was C 0.27, Mn 0.78 and Si 0.38 per cent. They were normalised for 40 min. at 915 deg. C. and tempered 1 hr. at 710 deg. C., after welding with coated rod. The average of four bars (Nos. 91 to 94) was 23.8 tons tensile, 16.2 tons yield point, 18.3 per cent. elongation and 55.1 per cent. reduction of area. When oil-quenched after heating 1 hr. at 895 deg. C. and tempered 1 hr. at 535 deg. C., all following preliminary normalisation 40 min. at 915 deg. C., two bars (Nos. 95 and 96) averaged 31.6 tons tensile, 23.1 tons yield point, 13.6 per cent. elongation and 41.4 per cent. reduction. The analysis of the weld metal of No. 95 showed 0.06 per cent. C., 0.33 per cent. Mn and 0.17 per cent. Si.

Report No. 17. *Tensile Tests on Welded Bars.*—Normalised 1 hr. at 925 deg. C. and tempered 1 hr. at 690 deg. C., after welding with carbon steel, rod *E*, and with alloy steel, rod *F*, both rods being coated.

Chemical composition: Heat No. 211, C 0.29, Mn 0.74 and Si 0.38. Heat No. 212, C 0.30, Mn 1.33 and Si 0.39 per cent.

Tests of Cast Steel Welded by the Oxy-Acetylene Method.

Report No. 18. *Tensile Test.*—Normalised 1 hr. at 895 deg. C. and tempered 1 hr. at 645 deg. C. The composition used was C 0.25, Mn 0.70 and Si 0.35 per cent. An unwelded bar (No. 105) gave 32.1 tons tensile, 17.9 tons yield point, 29 per cent. elongation and 48 per cent. reduction of area. Three bars (Nos. 106 to 108) welded with rod A averaged 30.7 tons tensile, 19.2 tons yield point, 15.8 per cent. elongation and 45.1 per cent. reduction of area. A second three bars (Nos. 109 to 111) welded with rod B averaged 29.0 tons tensile, 19.7 tons yield point, 17 per cent. elongation and 56.9 per cent. reduction of area.

Comments on Tests made with the Co-operation of the Author.

The author has reported results made known to him, obtained at numerous plants and laboratories, to give a comprehensive idea of what is probably the most effective welding done to-day on steel castings. It seems unnecessary to supplement the foregoing information by figures obtained from a great many other tests made by the company with which the author is connected. In nearly every case the test results in this Paper indicate results from the employment of good equipment, competent operators and discrimination in the selection of current, gas pressures, etc., and welding rods in particular.

To convey a clear idea of differing results obtained by the use of rods of the many kinds on the market, there will be found below a tabulation resulting from tests made under the author's general direction, showing averages of results when welding cast steel of ordinary composition. For obvious reasons the identity of the rod manufacturers is not disclosed. The author's experience indicates that when welding with gas, results as divergent as those found below are obtained, according to the nature of the rod employed:—

Averages from some Tests in Arc Welding 0.28 *per cent. Carbon Cast Steel, with various Welding Rods.*
(Bars normalised and drawn after welding.)

Rod.	M.S. Tons per sq. in.	Y.P. Tons per sq. in.	E in 2 in. Per cent.	R. of A. Per cent.
No. 1	29.0	21.8	15.4	40.0
No. 2	29.8	18.4	15.4	33.2
No. 3	23.8	16.2	18.3	55.1
No. 4	23.3	17.6	10.4	22.8
No. 5	23.0	17.6	8.8	26.2
No. 6	20.0	14.3	7.3	19.7
No. 7	20.9	16.8	6.0	13.1

It seems to be demonstrated that the best straight-arc welding can be done with specially coated rods. There are several varieties of these, produced by competitive concerns, which are capable of yielding good results. Generally, if not always, it is found desirable to employ reversed polarity when applying a coated rod. The poorest welds indicated in the preceding tabulation were made with bare welding rods.

At times information has been sought regarding the machinability of weld metal. Many Brinell readings were made at the Lebanon Steel Foundry to ascertain the average condition of hardness in the weld metal, in the zone immediately adjacent to the weld, and in the casting proper. The tests included readings

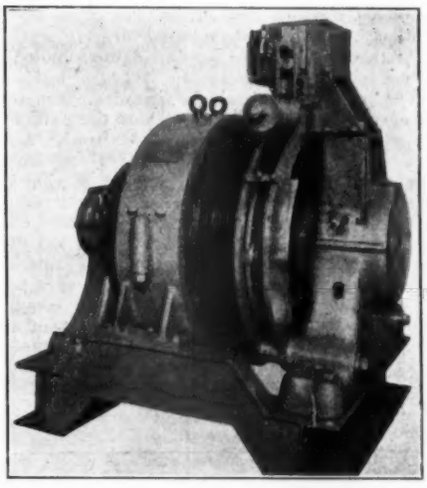

FIG. 2.—ELEVATOR MOTOR HAVING COMPOSITE FRAME INCLUDING STEEL CASTINGS WELDED TO ROLLED-STEEL PARTS.

without, and after, heat-treatment; after welding by the oxy-acetylene, the atomic-hydrogen, and the arc methods. The arc-welding tests included bare and coated rods.

Briefly summarising, tests on cast steel with an average composition of 0.25 per cent. carbon, 0.75 per cent. manganese and 0.38 per cent. silicon showed the following average Brinell hardness readings:—

Method of welding.	Before heat-treatment.	After tempering at 690 deg. C.	After a normalising treatment followed by tempering.
Arc	127	121	118
Oxy-acetylene ..	125	108	102
Atomic-hydrogen	155	137	110

Heat.	Bar.	Rod.	M.S. Tons per sq. in.	Y.P. Tons per sq. in.	E. in 2 in. Per cent.	R. of A. Per cent.
No. 211	No. 97	E	30.0	19.3	14.8	19.9
No. 211	No. 98	E	30.0	19.1	17.2	42.2
No. 211	No. 99	F	29.1	18.8	15.6	39.1
No. 211	No. 100	F	30.2	20.1	17.2	40.1
No. 212	No. 101	E	30.0	17.4	14.1	27.5
No. 212	No. 102	E	29.2	18.1	15.6	43.4
No. 212	No. 103	F	29.9	18.4	14.8	44.9
No. 212	No. 104	F	29.5	18.5	14.1	36.0

General Comments.

To prevent occupying too much space with comments as to fractures, references to these have been omitted from the tabulations. It may be said generally that the fracture of a butt-welded piece of cast steel occasionally discloses small gas cavities and particles of slaggy matter. The extent to which porosity and non-metallic material are present in weld metal seems now to be largely dependent on the nature of the rod and the skill of the operator. With a careless workman using good rod material, or a careful workman using inferior rod material,

gas cavities and non-metallic enclosures are apt to be found in varying degrees, irrespective of the method employed for welding and irrespective of the correctness of voltages, ampereages, gas pressures and other factors important to maintain, according to the method utilised for producing fusion. The complete elimination of gas appears to be very difficult to attain.

It is gratifying to the users of welded material as well as to the makers of such material, to realise that good welds are capable of being made by the arc method, by the oxy-acetylene method, and by the atomic-hydrogen method. This fact is indicated by the figures quoted in this Paper.

The principal purpose in presenting the foregoing test data has been to show the extent to which serviceable welds may be made with available facilities. The tensile test values demonstrate the possibilities when employing what are believed to be modern equipment and proper procedure, including the important factor of the human element, for it is highly essential that the operator be properly directed and conscientiously inclined. The results given are not claimed by the author to represent average practice. He is in no position to ascertain and comprehensively to evaluate the results of typical practice in all plants welding steel castings.

Examination of the data might, without further explanation, convey the idea that steel

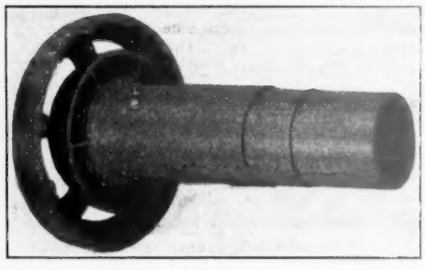

Fig. 3.—Armature Spider for Railway Motor having Steel Casting welded to Seamless Steel Tube.

foundrymen are concerned only with the values of welds obtained in tensile testing. This is not the case. Foundrymen are greatly interested in the growing technical literature regarding fatigue, shock, corrosion and other comparative tests of unweided and welded steels, which naturally have been made mostly on wrought steels and have resulted in instructive information that is being applied in the best engineering practice. Thus, a considerable amount of data is now available as a guide for estimating resistance to shocks and to fatigue in properly welded portions of fabricated structures. For the purpose of the present discussion it is regrettable that there have not been published or reported to the author sufficient data regarding impact, fatigue and certain other tests on welded cast steel, to make feasible the inclusion of such figures in this Paper. It is hoped that conclusive information relating to other than tensile tests, made on welded-steel castings, may be available soon for the information of engineers.

It is proper here to point out that there is an increasing dependence on the bend test for determining the ductility of welded joints. In this test, after bending, the extension of the deposited metal is measured, and the percentage of this elongation is recorded. This may ultimately prove to be the most satisfactory method of ascertaining the extent to which welded metal will stretch, this being a recognised indication of ductility. At the present time, on account of the almost universal dependence on the tensile test, the latter must be relied upon as the most satisfactory basis for comparison of data reported from different laboratories. The bend test, obviously, has the distinct advantage of application in many shops where no tensile testing machines are available.

Some experiments were made under the author's direction, in determining the elongation by means of the bend-test method. Butt welds of cast steel showed in some cases, an elongation amounting to 45 per cent. It is not proper to compare this value with the percentage of elongation as determined by the tensile test. The figures are not comparable with each other.

It is well to give a word of caution against dependence alone on averages in evaluating laboratory tests of welded specimens. While very valuable, averages do not tell the whole story. The extent of deviation from the average is a vital factor to the engineer, who would not be justified in selecting for highly important application a part which might, because of properties appreciably below the average, result in a

Fig. 4.—Cast-steel Hub for Welded Assemblage including Rolled Material for 1,700-h.p. Motor.

serious hazard. Consistency of results is essential for certain uses.

X-rays, gamma-rays and magnetic testing afford means of obtaining useful information about fusion welds. Obviously, the first two methods are commercially practicable only in the case of highly important applications, where the cost of testing is a small factor. The better chance for the commercial use of such methods for testing welded objects would seem to be where welding is done on a large scale, involving many pieces of the same kind, as in fabrication on a production basis. The utility of X-ray or gamma-ray examination in some such instances might be practicable in guiding the manufacturer in the selection of the best procedure, following the examination of pilot or experimental castings, before starting regular production. Such a practice would, of course, find its greater feasibility in connection with comparatively large parts, the cost of which would prompt hesitation in making machining or other destructive tests.

Mention has been made of the extent to which fusion welding has been employed advantageously in connecting steel castings to wrought-steel parts. Those engineers who have studied welding from an economic standpoint perceive the fallacy of forming by fusion fabrication many intricate portions of assemblages, some parts of which lend themselves nicely to welding fabrication, by shape, by number of pieces wanted, and by intended use.

It is believed that a number of illustrations showing the employment of steel castings in such composite construction will convey the best idea of its utility. Figs. 1 to 5 with their captions will probably be sufficiently explanatory without textual elaboration. It will be noted that both gas welding and arc welding have been employed. A great many cast-steel parts have been used as portions of composite assemblages which have been applied successfully, which cannot be illustrated, for lack of space.

The author hopes his explanations will demonstrate that the steel foundryman happens to occupy what might be said to be a "middle-ground" position in regard to welding. It is a position that combines long familiarity with fusion fabrication, with appreciation of the fact that steel castings have been used for certain purposes in the past where welded structures employing nothing but rolled shapes are now employed most economically. The discouraging aspect of this from the foundryman's viewpoint is counteracted by the realisation of his ability to cast intricate shapes successfully for many purposes, enabling him to co-operate with the welding engineer, to the end that composite structures may be produced to the best economic advantage for the consumer.

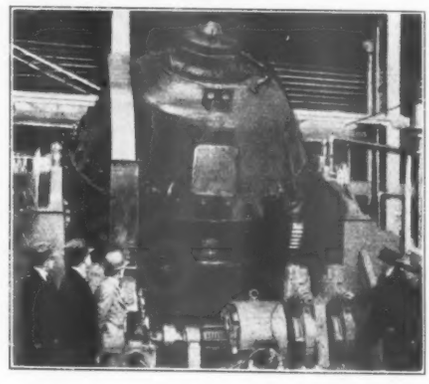

Fig. 5.—Ship Gyroscope constructed of Rolled Steel and Steel Castings welded together.

Emphasis has been given to the fact that engineers are not yet justified in placing dependence on a welded joint for the most severe stresses to which certain parts are subjected in industrial applications. In one other respect is the engineer's consideration required, namely, the difficulty of successfully welding many varieties of alloy-steel parts, both as to the homogeneity of the fused joint and as to the physical characteristics in the joint, gauged by the properties in the base metal when the latter is made from a special variety of steel. Much intelligent work has been performed by welding experts in the effort to develop in weld metal a fair approach to the chemical composition of alloy steel that has been welded. Progress has been made in this direction in connection with certain kinds of alloy steels. For example, special welding rods are used for parts made from austenitic manganese steel. But, among other problems, that of liquifying each of a great many grades of alloy steel without changing the proportion of each of several significant elements in the composition, is an extremely difficult one to solve. It will probably represent, for some time to come, a barrier against the very extended use of welding those parts of many grades of alloy steel which are serviceable largely in proportion to the special nature of their chemical composition.

For the various details that need careful consideration in connection with the use of the arc or the employment of gas, considerable intelligent study has been given by competent engineers, who have made sufficient tests (chiefly on wrought steels) to justify sound recommenda-

(*Concluded on page* 177.)

The Iron and Steel Institute.

JOINT ANNUAL MEETING WITH THE INSTITUTE OF METALS IN LONDON.

The autumn meeting of the Iron and Steel Institute in London last week was held jointly with the Institute of Metals, the programme commencing on Monday, September 12, when Dr. H. J. Gough, M.B.E., delivered the Annual Autumn Lecture of the Institute of Metals. A joint session was held on September 13. Col. Sir Charles Wright, Bt., K.B.E. (President of the Iron and Steel Institute), and Sir Henry Fowler, K.B.E. (President of the Institute of Metals), presiding.

Col. Sir Charles Wright, at the outset, remarked that it was his pleasure, as President of the Iron and Steel Institute, to welcome the President and members of the Institute of Metals, who were combining with the members of the Iron and Steel Institute to hold a joint autumn meeting. As was well known, by the very kind invitation of the American Iron and Steel Institute and the American Institute of Mining and Metallurgical Engineers, and their non-ferrous division, arrangements had been initiated for holding meetings of the Iron and Steel Institute and the Institute of Metals in America during the present season. Circumstances unfortunately prevented this, and it was found necessary to abandon the plans which had been made. He was sure Sir Henry Fowler would wish to join with him in expressing gratitude to their friends in America for the very cordial gesture which they had made; and perhaps it would still be possible to witness the fulfilment of the original plan in the not far distant future.

As an alternative, however, the Councils of the respective Institutes considered that the idea of a simultaneous meeting might still be maintained. It was a real pleasure to him during his term of presidency to take part in the present joint meeting, more especially as the President of the Institute of Metals, Sir Henry Fowler, was a very old and great friend of his, with whom he had worked very closely in the many high positions Sir Henry occupied during the great war. There were many who were members of both Institutes, and he felt there would be general agreement that the joining together of the two bodies on the present occasion would be enjoyed and appreciated by all.

Sir Henry Fowler thanked Sir Charles Wright very cordially for his remarks, and said the members of the Institute of Metals greatly appreciated the opportunity of holding a joint meeting with the Iron and Steel Institute. That morning he had heard someone who was interested in iron and steel say that one was bound to gain some information whatever metal one dealt with, and personally he hoped that would be true of the present meeting. Personal contact between all those interested in metals could not fail to be of benefit both scientifically and from the social and friendship standpoint.

A number of Papers were then read, and we append a report of the discussion on one of those presented by members of the Iron and Steel Institute. A report of other discussions will be published later.

DISCUSSION OF PAPERS.

Metallurgical Problems Arising from Internal-Combustion-Engine Valves.

Prof. J. H. Andrew thought he was correct in saying that the present was the first occasion on which a Paper had been presented before the Iron and Steed Institute on the subject of valves for automobile engines.

The trouble with steel for valves arose in the following way. Most of such steels contained elements such as silicon, chromium, molybdenum and tungsten, all of which tended to raise the α-γ change, and they also contained two elements, nickel and carbon, which tended to lower that change and produce the austenitic state. Many of the so-called austenitic steels might be austenitic immediately after they were made, but he thought, on viewing some of the author's photographs, that some of those steels, after annealing at high temperature for 1,000 hrs., rather showed a tendency to become martensitic and, therefore, harden. He thought the most dangerous element in valve steels was probably carbon, because the author showed clearly that carbon might be deposited sometimes in nodule form and sometimes coming out at the grain boundaries. If it was at the grain boundaries, it was, of course, dangerous, but if deposited at all there would be a tendency for the steel to assume a martensitic condition, which might be fatal for the valve under certain conditions.

He noticed the treatment the author gave was to heat the valves at a constant temperature for 1,000 hrs., but he took it that the author did not regard that as being equivalent to the treatment to which a valve was subjected in an automobile engine, where there were certain variations in temperature. He raised that point for the following reason. If an austenitic steel, which would tend to change to martensitic, were soaked for a long time at high temperature, that steel, if it did change to martensite, would change at a very low temperature, and every time it was cooled there was a possibility of a slight increment in the amount of martensite, whereas one cooling would perhaps be hardly sufficient to bring this about.

Composition and Cost.

Mr. S. A. Main thought the most interesting point about the Paper was that it showed that the valve steel which came out best, on the whole, was the most expensive steel of all. That probably explained the great number of valve steels which had been tried out, because it had been essential, owing to the high cost of that particular valve steel, to look round for cheaper products. The Paper fully confirmed that those cheaper products were not quite so good as the more expensive ones. Personally, he was very gratified to see that, because when his firm studied the question of valve steels some ten or twelve years ago, the problem of the aeroplane was becoming very acute; it was necessary to provide a valve steel for the very highest service. His firm at that time recommended the expensive type of steel to which he had referred, containing something like 30 per cent. of nickel, and he thought the present Paper justified their judgment in that respect.

He thought it would improve the Paper if the author would define more closely the steel upon which he had worked in the researches referred to on pages 26 to 28, and again on pages 30 and 31. It was referred to simply as D.T.D.49A, and the specification, which was given at the bottom of page 25, was not at all definite; it merely gave maximum limits and minimum limits. By reference to Table I it would be seen that quite a number of steels of vastly different compositions could satisfy that specification, and he was sure, therefore, that it was important to know the exact steel which had been used to obtain the results given by the author.

Dr. W. H. Hatfield said it was desirable to realise what the author's expectations really were. When the author spoke of 1,000 hrs. of service, it should be realised that that was equivalent to 100,000 to 200,000 miles of flight, which was a terrific demand to make upon such metals. He had gone through the Paper very carefully, and he had also had the advantage of being in fairly intimate contact with the author during his professional work, so that he could state confidently that the Paper could be regarded as a most authoritative and accurate statement of the subject. Personally, he did not think he took exception to any of the author's conclusions. In effect, the author said that none of the steels referred to had all the characteristics that were required, but he pointed out that there were several of them—steels of widely-differing characteristics—which had given very good service. The austenitic type of material containing tungsten had given most excellent service, and personally he thought that that steel was perhaps the one which, with minor modifications in composition, would be adopted ultimately. But it had also to be borne in mind, as the author had said, that the silicon-chrome steel had performed remarkably well in the valves of aero engines.

The difficulty which investigators experienced, lay in accurately visualising the conditions with which the valve would be faced in service. The silicon-chrome steel had excellent resistance to oxidation. It had comparatively little strength at elevated temperatures, but, as the author had said, its high critical range was a very great advantage, because the allotropic change was not encountered within the life of the valve. That was one steel. It had been used in very large quantities, and was being so used, and yet its characteristics were utterly different from those of the nickel-chromium-tungsten type.

He must confess that he did not see the need for adding 30 per cent. of nickel to these steels. That might be inferred from his remarks on a previous Paper! He was now speaking, however, on purely scientific grounds. He thought 10 per cent. or 12 per cent. of nickel was quite sufficient to meet the conditions which the author had in mind.

Notched-Bar Values.

He was very grateful to the author for referring, at the beginning of his Paper, to the fact that a valve steel should possess the highest possible notched-bar value at high temperatures. So often the properties of steel at ordinary temperatures were asked for, when those properties at ordinary temperatures had really no relation to the service conditions. It was very valuable that the author should emphasise that. As showing the difficulties encountered by the metallurgical investigator in dealing with problems of the kind in question, he would draw attention to items (10) and (12) in the first paragraph of the Paper. Item (10) was "Sufficient hardness to withstand excessive wear in the stem," and (12)—a requirement which was constantly met with—was "The capacity of being machined easily and satisfactorily by ordinary methods." That last condition had been one of the greatest hindrances to the development of ferrous metallurgy since he had been connected with the subject, and he did hope that engineers would realise that there were ready means nowadays of fabricating these materials with special characteristics, so that the handicap which such a clause imposed might be removed.

He regarded the Paper as an excellent one and one which, if carefully studied by those engaged in research in the field with which it dealt, would help to further progress.

Colonel N. T. Belaiew said that some years ago he had suggested some typical macrostructure might be evolved for such things as shafts and valves, and the present Paper contained a certain approach to that structure. He would therefore like to ask the author to consider publishing a larger number of such macrostructures as had proved in practice to be the best, and then it would be possible to see what kind of mechanical work and what amount of work were best suited for every type of valve.

Mr. T. H. Turner said that some years ago he examined American aero valves in which the structure was austenitic at the head and martensitic in the stem, and, when reading the present Paper, he examined the old samples, and was surprised to find the austenitic head had gone rusty while the martensitic stem was all right. In those valves there was a difference in the structure just at the root of the head, and he would be interested if the author could say whether trouble had been experienced with those valves breaking where the austenitic and martensitic structures joined.

There was another question which he would like to raise and which perhaps came under the subject of the Paper. There could be no doubt at all that the old cast-iron head cast on to a steel stem did very well for the "soft" engines. He wondered whether the nicrosilal types of cast irons cast on to a steel stem, if they were cast in the correct shape, would not give good service. He had not seen any work done on that line.

Sir Henry Fowler said he had taken a great interest in the Paper, because during the war he had been greatly interested in aero engines. Though it was thought at that time that great work had been done, there could be no doubt that since then a very considerable advance had been made, as was evidenced by the length of time which an aero engine could now run without repairs. That was the problem which had to be faced during the war, and it was the 13 per cent. chromium which gave a hope that improvement would be, as it had now proved to be, possible.

The Author thanked the meeting for the very kind reception they had given to his Paper, and said he would reply to the discussion in writing.

Opening of Falkirk Technical School.

With the opening which took place officially, on September 5, of this palatially-constructed and admirably-equipped structure at Falkirk, so far as educational facilities are concerned, is brought right into line with the principal provincial towns, not only in Scotland, but in Great Britain. Incorporating the very latest ideas and taking advantage of the numerous improvements, the product of ingenuity and experience, Falkirk Technical School may be said to represent a monument to and a milestone in the phenomenal progress and development of educational establishments in Scotland. The proceedings at the official opening ceremony were presided over by the Rev. George Turner, M.A., Balfron, chairman of the Education Committee of Stirling County Council, while the school was declared open by Mr. W. W. M'Kechnie, C.B., secretary to the Scottish Education Department.

Accompanying the chairman and Mr. M'Kechnie on the platform were Mr. C. E. Horsburgh, vice-convenor of the County; Sir George and Lady Stirling of Glorat; Provost Archibald Logan; ex-Provost Gilchrist, Falkirk, vice-convenor of the Education Committee; Mr. George M'Laren, Stenhousemuir convenor of the Property Committee; Mr. H. M. Patrick, H.M. Inspector of Schools; Mr. J. J. Lockhart, Rector of the new Technical School; Mr. J. J. Robertson, Rector of Falkirk High School; Mr. Fred Johnston, J.P., Falkirk; Mr. Hugh P. Black, chairman of the first Education Authority of Stirlingshire; Mr. James Learmouth, County Clerk; Mr. J. Coutts Morrison, Director of Education for the County; Mr. A. N. Malcolm, F.R.I.B.A., architect of the Education Committee; Mr. A. Balfour Gray, Town Clerk of Falkirk.

The Chairman in his opening address said that they met that day to mark the consummation of the work and thought of several years. It was on June 19, 1924, that the decision had been reached which ultimately led to the erection of the handsome building in which they were assembled. On that date a special meeting of the Education Authority considered the report of the Director of Education on post-qualifying instruction and also the school accommodation required in Stirling, Falkirk and elsewhere, and arising out of the arrangements proposed for Falkirk the Property Committee were instructed to make inquiries regarding a suitable site for the erection of a new school in Falkirk for advanced-division pupils. The courses to be instituted at Falkirk Technical School would ensure that such pupils would spend the last years of their attendance in a most profitable manner, and that they would be able to embark on a post-qualifying course which it would be possible for them to complete when their school days were over. The school would fulfil other very important functions as there would be inaugurated a leaving-certificate course of such a nature that pupils who did not have an aptitude for acquiring foreign languages but had a bent towards engineering, commerce, or domestic science would be able to advance to the higher branches of these subjects. It was hoped that a day continuation class in foundry practice and engineering would be inaugurated, and that arrangements would be made with the employers whereby selected students would spend one part of their week in the school workshops and the other part in the foundries or engineering workshops of their employers. It would be evident from what he had said that that day marked an important event in the educational history of Falkirk.

Mr. W. W. M'Kechnie, C.B., in declaring the building open, said that they were glad that day to celebrate the completion of the new school after many years of waiting, but he wished to say at the outset that it was a source of grief to him, as it would be to all who knew him, that Mr. Brown, the late chairman of the Education Authority, did not live to see that day. It had taken a long time to build the school, but now it was built, it was fitting they should consider the rôle it would play in the educational economy of Falkirk. In the first place, it would relieve congestion in a number of existing schools. Then there was the High School, and in it, as in many secondary schools, a number of the pupils who embarked on the course failed to complete it, and a considerable proportion of them did not receive the education that was most suited to their tastes or capacities and their future callings. Of that there was not a shadow of doubt, and it was most earnestly to be hoped that such pupils would be attracted to the new school, where they will be asked to apply their minds to activities that make a readier appeal to their interests. Schools of this type are indubitably to be classed among the most fascinating of educational experiments. We are well accustomed to the older type of education, which used books as tools and made the Universities and the professions its goal, and are justly proud of the extent and quality of its development in Scotland; but it is not suited to all who follow it. It never was; but the proportion of suitable pupils in secondary schools is almost certainly less to-day than it was 30 years ago, because the number of secondary pupils has increased enormously since the beginning of the century. They accordingly required a new type of secondary education, and the question was what it should be. It is accepted that modern schools should provide accommodation, equipment and staff for the teaching of technical subjects. This school has a fine gymnasium, a swimming pool and space for games. But something more is needed. It would appear that in this new type of school the teachers would have to make a special effort to get down to the real needs, immediate and future, of the children whom they have the privilege of training during the most impressionable years of their lives. Nothing must be pedantic. Everything should be so ordered that tastes and ideals may be raised as high as they can go. Thoroughness should be the keynote of every lesson. This school in particular provides admirable facilities for special trade instruction for iron moulders and patternmakers, metal workers, upholsterers and engineers. That is a most important development. These facilities should help very materially to increase the skill of the artisans, to give some knowledge of the scientific principles underlying the different crafts and so to enhance the interest, and it is hoped that full advantage will be taken of them. I have the very greatest pleasure in declaring the school open, and in doing so I would express the most fervent hope for its success. May its history be such that in the years to come it will fully justify the anxious thought, the imagination and the foresight of those who conceived and planned it.

Falkirk's Foundry Industry.

Provost Logan (Falkirk), speaking on behalf of the citizens of Falkirk, said Falkirk appreciated the efforts of the Education Committee in trying to institute a school such as the one they were now in. Falkirk, he thought, could in the past be credited with having sent from within its confines many eminent men who had made their mark in different parts of the world. That had been done without any very great educational institutions in the borough. It had been done, he thought, because of the inward grit and the self-determination of the citizens to master whatever they put their minds to. With regard to the new school, it should help to make it easier for the generation that was now coming on to maintain that very high reputation which their elders who had gone forth into the world had succeeded in building up for Falkirk. In these present times, when they were strenuously endeavouring to attract new industries to the town, it was well that they should have such an educational institution where the young minds could be moulded in the technicalities of any industry that might come to the town. So far as the staple industry was concerned, they had facilities in the school for the giving of such a training and insight into that industry as had never been dreamed of before. Falkirk had risen high in the estimation of the world for the production of that class of goods which were manufactured in the borough. That reputation had been gained very much on what he might call the rule-of-thumb basis. Many employees connected with the industry carried on in the town were in the position of having their trade handed down to them, from father to son. They did their work without asking why they did it. They did it because they had seen somebody else do it, because it brought their daily bread, and sought not to learn the principles of and reasons for what they did. In the new technical school they would be able to teach these people the reasons for things being done, what was its result, and the cause and effect of the whole thing. That would enable them in the near future to turn out much better artisans than they had done in the past. If that was so then the name of Falkirk would be carried to a higher standard than ever before. He hoped that the new school would meet with the success desired for by those who had conceived and constructed it and who had given it their earnest thought and consideration over long and weary years.

Foundry Department.

The school contains a model foundry equipped on generous lines. In the foundry department are metal and wooden pattern shops, a tool room and moulding and casting shops. There are also foundry, chemical and microscopical laboratories planned and equipped particularly to afford facilities for the chemical analysis of metals under general works laboratory routine. The equipment of the foundry department includes a sand-mixing plant with Pneulec Royer disintegrator, a 1-ton cupola, a 400-lb. oil-fired furnace, a 60-lb. oil-fired furnace, a double-cased core stove, a 1½-ton overhead electric crane, a circular-saw bench, combined planing and thicknessing machine, a 30-in. band saw, an 8-in. lathe, a high-speed recessing and boring machine, a hand-power trimmer and a dust-extracting plant. It was designed by Mr. F. J. Cook, a Past-President of the Institute of British Foundrymen.

Imported Wrought Hollow-ware.

Marking Order Recommended.

The Standing Committee appointed by the Board of Trade under the Merchandise Marks Act, 1926, in its report on the recent inquiry in respect of an application for the marking of imported wrought hollow-ware of iron or steel, states that it has come to the conclusion that an Order in Council ought to be made. It is recommended that an importation order should be made as well as a sale order, and that it should apply to imported goods of the following descriptions: Wrought hollow-ware of iron or steel of a description commonly used for domestic or agricultural purposes, whether self colour (plain), galvanised, tinned, japanned, painted, lacquered or varnished, but not including hollow-ware of tinplate, enamelled hollow-ware, or kegs and drums. Hollow-ware imported as part of another article is recommended for exemption.

Regarding the method of marking to be adopted, the Committee recommends that the indication of origin should be impressed or embossed either on the article itself or on a metal label soldered or riveted to each article. It does not think it desirable to prescribe a minimum size of lettering for the indication of origin, and prefers to rely on the wording of the Act, which requires all indications of origin to be given conspicuously.

Dagenham Works of the Ford Motor Company, Limited.

On September 15 members of the Iron and Steel Institute and of the Institute of Metals visited the Dagenham Works of the Ford Motor Company, Limited. These works, then in course of construction, so far as the blast-furnace portion of the works is concerned, were described at length in a Paper given by Mr. W. R. Brown before the annual meeting of the Iron and Steel Institute in May last, being fully reproduced in our columns. In view, however, of the present occasion, it may not be out of place to recapitulate the principal features of the blast-furnace plant.

Fig. 1.—Aerial View of the Ford Works at Dagenham, Essex.

Blast-Furnace Plant.

In passing, it may be mentioned that the new Dagenham works, covering an area of twenty-eight acres, are built on a corner of Essex which a few years ago was a tract of waste marsh land. The type of Thames gravel common to the district is here covered by a layer of mud 40 to 50 ft. deep, and it was necessary that every load placed on such ground should be carried on piles, those used being 14-in. sq. of cast reinforced concrete. Under the blast-furnace plant, not including coke ovens, boilers or blowing plant, some 7,000 piles have been driven, while the skip-pit was sunk as a pneumatic caisson, so that any risk was avoided of the surrounding sub-strata becoming de-watered and thus jeopardising the furnace foundations.

The blast furnace is designed to produce 500 tons a day of high-silicon special iron. The wharf can accommodate ore-carrying vessels up to 12,000 tons, and the discharge appliances consist of two unloaders, of Mead-Morrison design, running on a high line, 500 ft. in length, above the wharf proper. The high line connects with the shore, and, maintaining the same elevation throughout, it traverses in turn the sinter-plant bins, the coal-transfer station, the furnace bunkers and ore-crusher bunker, terminating within the foundry, where foundry coke is delivered to the cupolas. On the western side of the high line lies the stockyard consisting of an ore trough, 25 ft. wide, and a yard, 195 ft. wide, the whole area being covered by a reinforced-concrete raft carried on piles. The storage capacity is 100,000 tons of ore and limestone and 33,000 tons of coal. Two self-propelling 50-ton electric cars operate on the high line, besides which there is a reclaiming car of 50 per cent. greater capacity, primarily intended for handling coal. A fourth car, used as a trailer, completes the rolling-stock equipment of the high line. A bridge crane spans the stockyard, capable of handling 800 tons of ore an hour.

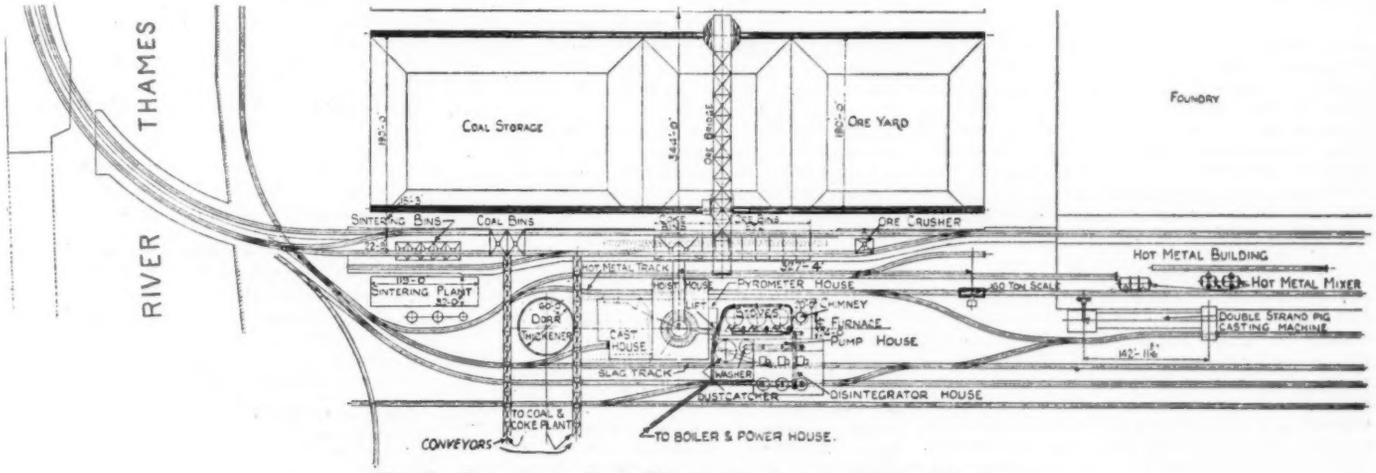

Fig. 2.—Plan of the Blast-Furnace Plant at the Ford Works.

The furnace has 10 tuyeres and the hearth jacket is sea-water cooled. The jacket itself con-

sists of a heavy mild-steel plate encircling cast-iron staves through which the cooling pipes are carried. The furnace lining is built entirely of 9-in. and 13½-in. machine-pressed brick squares, keys and arches. High-alumina bricks are used in the hearth and bosh. The height of the furnace stack is 87 ft.

Dry-quenched coke will be used, which, after thorough screening, will be conveyed to the furnace bins by belt. Ore, stone and other materials are withdrawn from the bunkers through a continuous line of double-lip bin gates operated by compressed-air cylinders which are carried on the scale cars for receiving the materials from the bins. These 10-ton scale cars then convey the material and deposit it in the skip tubs. Double skips are used, which, after hoisting, discharge the materials on to a McKee revolving distributor. The large and small bells are operated by air cylinders working on blast pressure, with compressed air through a reducing valve as a standby.

The stoves are constructed on the Schiffer-Strack system, which requires the use of clean gas with a dust content of not more than 0.02 grain per cub. ft. The stove fillings consist of hexagonal chequers; those in the top 20 to 24 ft. having a single 8-in. round passage-way and those in the lowest section being pierced by nineteen 1¾-in. circular holes, while between these two sections intercommunication is provided by two rows of seven-hole chequers. The stoves are three in number, measuring 100 ft. high and 20 ft. in dia., the heating surface per stove being 140,000 sq. ft.

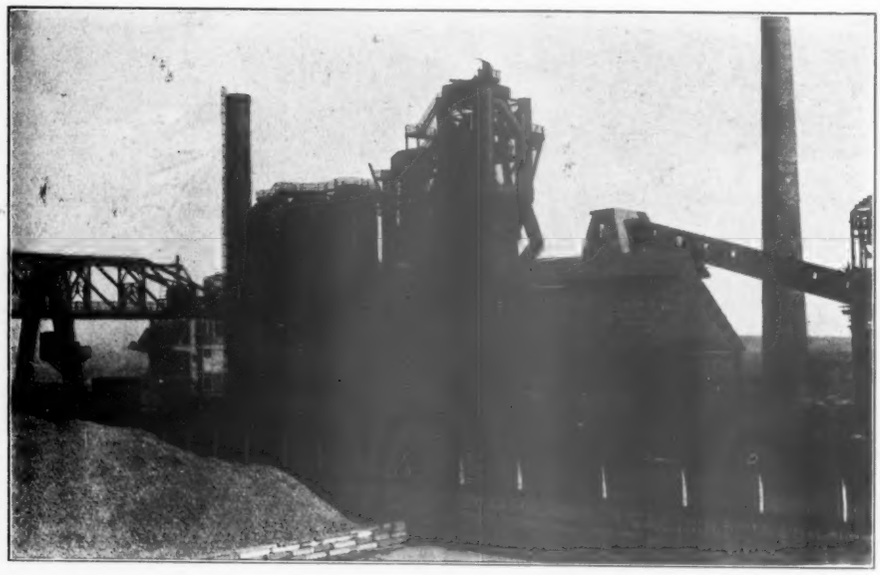

Fig. 3.—General View of Blast Furnace and Hot-Blast Stoves with Ore Storage in Foreground at the Ford Works, Dagenham.

Engineering Shops.

The engineering shops, where almost every process in the building of a modern car, from making the rough engine casting to assembling the finished product, is carried out, fronts the river. The floor is 28 acres in extent. It is composed of one unbroken slab of reinforced concrete and required 100,000 tons of concrete to complete it, and 2,500 miles of reinforcement steel are built into it for added strength. This is one of the largest contracts of its kind ever carried out, and to execute it the contractors erected a sand-and-gravel conveyor and mixer which was one of the largest ever used in Great Britain, and enabled them to make and lay 500 cub yds. of concrete in eight hours.

The engineering shops themselves required 13,500 tons of steel pillars and girders, whilst the roof comprises a million sq. ft. of patent metal, and 600,000 sq. ft. of glass. The gutters themselves are among the largest ever designed, and it would be possible to take a four-mile walk along them without retracing one's steps. The building comprises three large shops. On the north side—furthest from the river—is the foundry and hot-metal building, where molten metal is received from the blast furnace and the rough castings are made. This shop alone measures 1,300 ft. by 300 ft., and is equipped with the most up-to-date plant for handling hot metal at high speed. Next to the foundry is the manufacturing shop—1,000 ft. by 300 ft. Here the rough castings are taken and turned into components. At the southernmost end of the building is the assembly shop.

The factory will also have its own power house, capable of producing enough electricity for a town of 50,000 inhabitants. The power house is still in course of construction. The coke ovens (by Coppée) are nearly complete and will carbonise about 800 tons of coal per 24 hrs.

Access to the works from the river is obtained by the new Ford jetty, where 12,000-ton ocean-going vessels, as well as many smaller boats and barges, can berth simultaneously. Special provision is made for passenger traffic by the installation of a floating pontoon, where those who arrive at the works by river can disembark at any state of the tide. The Ford Company proposes to make wide use of water transport, and already has its own launch running regularly between Westminster and Dagenham.

Silicosis and Asbestosis.—A Memorandum on the industrial diseases of silicosis and asbestosis has been issued by the Home Office. It deals with the origin and development of silicosis, means of prevention, provision for compensation, medical arrangements for examination and certification of cases. The Memorandum points out that during the last three years there have been 80 cases, including 30 deaths among workmen employed in ganister mines and silica brick works; 179 cases, including 25 deaths, in the getting and manipulation of sandstone at quarries or on premises worked in conjunction therewith; 322 cases, including 87 deaths, in the pattern industry; 81 cases, including 32 deaths, in the metal industries, including metal grinding and sandblasting; and 91 cases, including 20 deaths, in coal mines. These figures show a total of 753 cases, of which 194 ended in death. There is a final note on asbestosis. Copies may be obtained from H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. (Price 3d. net.)

Growth of Cast Iron.

In a recent issue of Archiv für das Eisenhüttenwesen there is a report by E. Scheil of investigations made at the Research Laboratory of the United Steelworks Company, Dortmund, on the growth of cast iron. The points to which special attention was directed were the changes in structure due to anealing below the critical point and the influence of the dimensions of the test-piece on the values obtained for the growth. The experiments were made on specimens 100 mm. long with diameters varying from 5 to 100 mm., heated in an electric furnace at 600 deg. C.

The characteristic change in the structure is the decomposition of the pearlite into ferrite and free graphite. In the inner zones, into which gases cannot penetrate along the graphite veins or flakes, this is the only change observed, but in the outer zones there appears a further constituent, which Scheil calls *x*, surrounding the graphite flakes. On deep etching this has the appearance of graphite and has been so described. The present investigation, in which the material was examined by means of X-rays and also by measurement of the coercive force, showed that this constituent occurred only near the surface of the pieces annealed in air and in carbon dioxide and not in those annealed in a vacuum, and was therefore presumably due to oxidation of some element in the cast iron. Samples were accordingly prepared from Armco iron and carbon to which additions were made of silicon, manganese and phosphorus. These were annealed at 600 deg. C. in air for 300 hrs., the constituent *x* only being found in those containing silicon, and in these very profusely. The conclusion is therefore drawn that it is probably a mixture of ferrite and a silicate of iron. The graphite flakes were slowly gasified by the oxygen, oxides of iron forming at the same time, until no more graphite was present. If the graphite flakes are rapidly surrounded by an oxide layer, this exerts a strongly restraining effect on the decomposition of the cementite.

Corresponding to the changes in the structure the amount of growth (change in length) decreased with increasing cross section of the specimens; on the other hand the centre of thick specimens increased in length more rapidly than the rim, causing a bulging at the ends. The change of volume due to the decomposition of cementite was determined as 12.8 per cent., in close agreement with that calculated by Benedicks under certain assumptions. The technically important conclusion is drawn from the tests that any measurement of alterations in length gives value for the growth of cast iron which are too high, under certain conditions to a large extent. Since values for the growth have in the past been obtained in this way, cast iron has appeared to be worse in this respect than it actually is. Similarly the use of thin specimens in the laboratory gives higher values for the growth than found afterwards in thick-walled castings, and may lead to the unnecessary substitution of other more expensive alloys for cast iron. Reviewing on the whole the results it may be said that former measurements of the growth of cast iron may only be used for qualitative comparisons.

Armco Enamelling Iron.—The American Rolling Mill Company, of Middletown, Ohio, is producing an improved enamelling iron known as "crystal etched," which is said to possess exceptional bonding qualities. This new sheet, an "Armco" development, is produced by a new process, and is expected to effect large savings to the porcelain enamelling industry. As the adhesion between the enamel and the metal will be uniformly strengthened, rejection losses will be decreased, and there will be greater resistance to chipping and flaking. Undesirable imperfections, such as black specks, will be markedly reduced.—"American Metal Market."

Mould Materials for Non-Ferrous Strip Ingot Casting.

By G. L. Bailey, M.Sc.

(*Concluded from page* 156.)

The structure of the central portion of the second bar was similar to that of the first, but in this case the surface layers were free from pearlite.

Summary of Results of Vacuum Annealings of Cast Irons.

The following facts are apparent from the above experiments: (1) On exposure to the atmosphere, a cast iron absorbs oxygen which causes evolution of gases on heating; (2) this gas evolution commences at 700 deg. C. and becomes rapid at 750 to 800 deg. C., and (3) gas evolution is accompanied by the decarburisation of the pearlite in the surface layer of the iron.

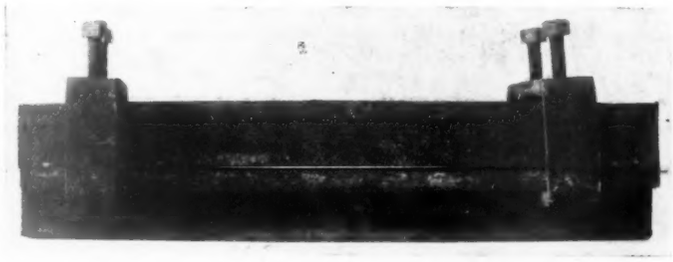

FIG. 10.—MILD-STEEL INGOT MOULD AFTER 6 HEATS. × ⅛.

Behaviour of Non-Pearlitic Iron.

In view of the fact that pearlite appears to be the main constituent reacting with superficial oxide, tests were made of a small plate of non-pearlitic iron, prepared by cooling a high-silicon iron slowly from 900 deg. C. The structure of the plate was almost entirely ferrite and graphite (Fig. 8). The volume of gas evolved on testing was 0.04 c.c. on the first cast and 0.08 c.c. on the second. These amounts are much less than those obtained from normal grey irons, but are sufficient to indicate a small effect due to the presence of graphite—due either to reaction with oxide where contact with the graphite flakes is sufficiently good or to the retention of air in the mould surface, particularly where graphite is mechanically removed from the surface layers.

The Temperature Attained by the Mould Face During Pouring.

In experiments described in a later section of this report, measurements were made of the temperature gradients in the walls of a grey cast-iron ingot mould during and immediately after pouring a 12 in. × 6 in. × 1 in. ingot of 70:30 brass. Two series of measurements were made, one in which the stream of metal did not touch the mould face and a second in which the stream struck the portion of the mould carrying thermocouples. In each case the temperature of the inner face of the mould reached a maximum in 12 secs. after pouring. Extrapolation of the curves obtained (Fig. 9) showed that these maximum surface temperatures were approximately 520 and 800 deg. C. respectively, indicating that the mould surface is sufficiently overheated by impingement of the molten stream to permit a rapid evolution of gas due to the reaction discussed above.

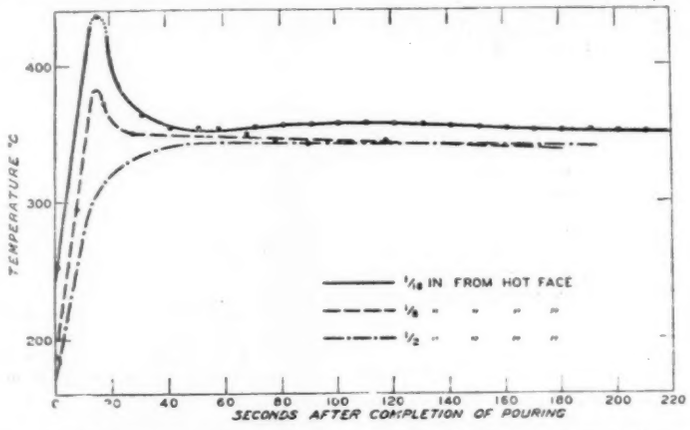

FIG. 11.—TEMPERATURE VARIATIONS IN WALL OF MILD-STEEL INGOT MOULD.

Discussion of Results.

Examination of various possible causes of the "blowing" of cast-iron ingot moulds has indicated that this only occurs when pearlitic irons are superficially oxidised. Graphite alone produces only a small amount of "blowing," but this phenomenon is liable to occur with a wide variety of ferrous alloys in which the content of combined carbon is high. The presence of an oxide film on the surface of a cast-iron ingot mould is very difficult to avoid entirely. In ordinary works practice the thickness and nature of the usual type of mould dressing provide some protection against oxidation and against local overheating during pouring, but a thin mould dressing is relatively ineffective in this direction. In the small-scale experiments described, cast iron was found to oxidise sufficiently on free exposure to air at atmospheric temperatures to produce "blowing" on reheating, and experimental trials of cast-iron ingot moulds under conditions designed to minimise oxidation failed to reduce "blowing" to any great extent. Freedom from "blowing" could be secured by the application to the mould surface of a thick metallic coating, but such coatings showed the disadvantage of flaking or blistering with continued use owing to the difference between the coefficients of thermal expansion of the coating and the basis metal. It appears, therefore, that a remedy for this defect must be sought in the use of a carbide-free mould material.

The Properties of Mould Materials Affecting their Permanence.

Reference has already been made to the fact that steel containing only 0.1 per cent. carbon

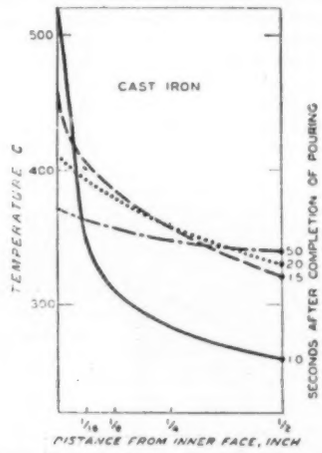

FIG. 12.—TEMPERATURE GRADIENTS IN MILD-STEEL MOULD STEEL.

proved free, under normal conditions, from the liability to "blowing" to which cast iron is subject, and preliminary trials were therefore made of steel-ingot moulds. It was found that such moulds warped so rapidly and seriously as to become useless after several casts. Fig. 10 shows the nature and amount of the distortion of a 24-in. long-strip ingot mould of mild steel (0.1 per cent. carbon) after only six heats had been poured in it.

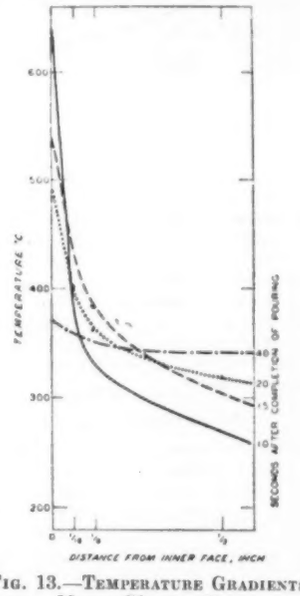

FIG. 13.—TEMPERATURE GRADIENTS IN MOULD-WALL FACE FOR INTERVALS OF TIME USING CAST-IRON MOULDS.

The change of form produced in a mass of material such as an ingot by non-uniform heating and cooling, is due to thermal stresses arising

from variable changes in volume through the section. Other factors being equal, the thermal stresses and resulting distortion are higher the greater the variation in temperature in the specimen. Measurements were made of the changes in temperature at different points throughout the wall of the ingot mould during and subsequent to the casting of the ingot. From these data the temperature gradients at any stage could be obtained. Several materials were so tested, and the properties required for the avoidance of warping were deduced. Confirmatory tests were made using a small-scale mould, and these were finally extended to the casting of brass in larger moulds of promising materials.

Temperature Gradients in the Wall of a Mild-Steel Ingot Mould During and After Pouring.

Measurements were made of the variations in temperature of thermocouples set into the wall of a mild-steel mould at distances of $\frac{1}{16}$ in., $\frac{1}{8}$ in. and $\frac{1}{4}$ in. from the inner surface. The mould used was of the usual type for 12 in. × 6 in. × 1 in. ingots, with walls $1\frac{1}{8}$ in. thick, and $\frac{1}{8}$-in. dia. holes were drilled for the thermocouples near the centre of one face. To ensure rapidity in recording, platinum/platinum-rhodium thermocouple wires of only 0.2 mm. dia. were used with the bare welded junction in contact with the bottom of the hole. The mould preheated to 100 deg. C. and dressed with lampblack, was filled with 70:30 brass by pouring at 1,100 deg. C. in a time of 10 secs. Readings of the temperatures of the thermocouples were simultaneously at 5-sec. intervals.

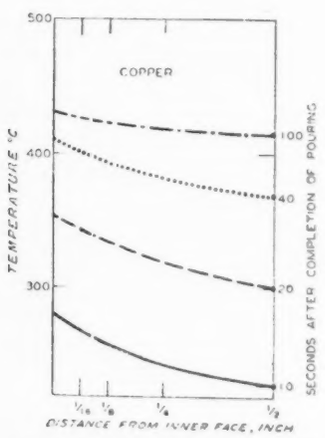

Fig. 14.—Temperature Variations in Wall of Cast-Iron Ingot Moulds.

The time-temperature curves obtained for the three positions are shown in Fig. 11. From these results curves were plotted showing the temperature gradients in the mould wall at various intervals of time after pouring (Fig 12).

The Thermal Stresses in a Mild-Steel Mould.

The rapid changes in temperature of the inner surface layer cause large and rapidly-changing stresses in this portion of the mould wall. The inner face expands rapidly during the 10 seconds immediately after pouring. The mould tends to open at top and bottom to accommodate this increase in length, but is held by the clamps and by the rigidity of the thick mass of cold metal at the back. In the hot layers of the mould a severe compressive stress is thus set up which is largely relieved by plastic flow.

After 10 seconds from the completion of pouring the conduction of heat through the mould wall exceeds the rate at which heat is supplied to the inner face by the ingot. The inner surface layers then cool somewhat while the main body of the mould is heating up. The stresses at this point are reversed and a tensile stress is set up on the inner face and a compressive stress in the outer layers. In the initial stages some stress may be relieved by permanent extension of the inner face, but as temperature gradient diminishes considerable stresses are set up below the elastic limit and the mould wall reaches an approximately uniform temperature with a tensile stress on the inner surface and compressive stress on the outer.

These stresses are largely relieved by warping, the mould becoming concave on the inner face and convex on the outer, as shown in Fig. 10.

In the case of the copper mould the maximum temperature difference within the wall occurred during the first 20 seconds of heating up, but did not reach 100 deg. C. There was no fall in temperature of the inner face while the back heated up, the mould attaining an approximately uniform maximum temperature. Under these conditions the thermal stresses set up within the wall would be small, and the entire absence of elasticity in annealed copper enables them to be relieved by plastic flow.

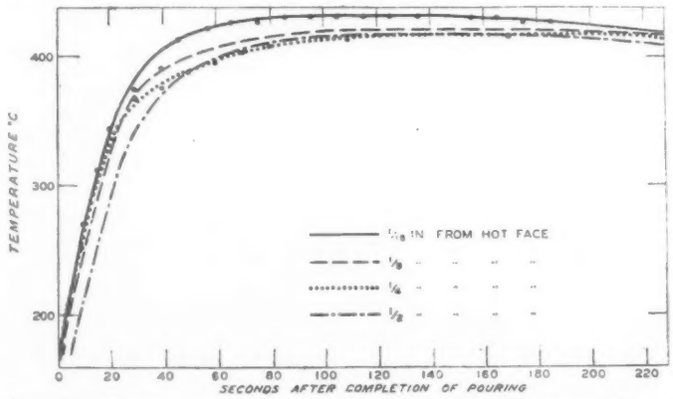

Fig. 15.—Temperature Variations in Wall of Copper Ingot Mould.

Temperature Gradients in Moulds of Grey Cast Iron and Copper.

Measurements were made by the same methods to determine the temperature variations in the walls of a mould (12 in. × 6 in. × 1 in.) of cast iron, which shows little warping under ingot-mould conditions, and of copper, a material which is now being employed for water-cooled moulds. The thickness of the wall of the cast-iron mould was $1\frac{1}{8}$ in. and of the copper 1 in.

The temperature gradients in the mould wall at various intervals of time after pouring are shown in Figs. 13 and 14. Curves showing the variations in temperature in the wall of the cast-iron mould were similar to those shown in Fig. 13, and those for the copper mould are shown in Fig. 15. The maximum temperature reached by the inner face of the cast-iron mould was about 100 deg. C. below that for mild steel. This temperature is probably affected by slight variations in the distance of the stream of metal from the mould face. To ascertain the maximum temperature to which the cast-iron mould face can be heated by the stream of metal, a second experiment was carried out in which the stream of 70:30 brass was allowed to impinge fully on the portion of the mould wall on which measurements were being made. The approximate maximum temperature gradient produced under these conditions in cast iron is shown in Fig. 9, together with the curve of the average gradient reproduced from Fig. 13.

Thermal Stresses in Moulds of Grey Cast Iron and Copper.

The thermal stresses set up in the wall of a grey cast-iron mould are of the same order as those in a steel mould, and the absence of warping is due to the different mechanical properties of the cast iron. The initial expansion of the inner layers causes a small permanent deformation by compression, followed by a reversal of stress on cooling down as in the case of mild steel. The tensile stress set up in the inner surface causes transverse cracks to appear at comparatively low stresses owing to the weakness and lack of ductility of the material. The presence of these cracks prevents warping, further stresses being relieved by a slight opening of the transverse cracks, producing a condition of the inner surface familiar to users of such moulds (see Fig. 16).

Properties Necessary for the Avoidance of Warping in Ductile Material.

From a consideration of the foregoing results the following properties would appear to be necessary in a mould material to minimise distortion: (*a*) A high thermal conductivity, to reduce thermal stresses; (*b*) a high elastic limit, especially at raised temperatures, to minimise plastic deformation, or (*c*) a negligibly-low elastic limit, to permit the entire relief of stresses by plastic deformation.

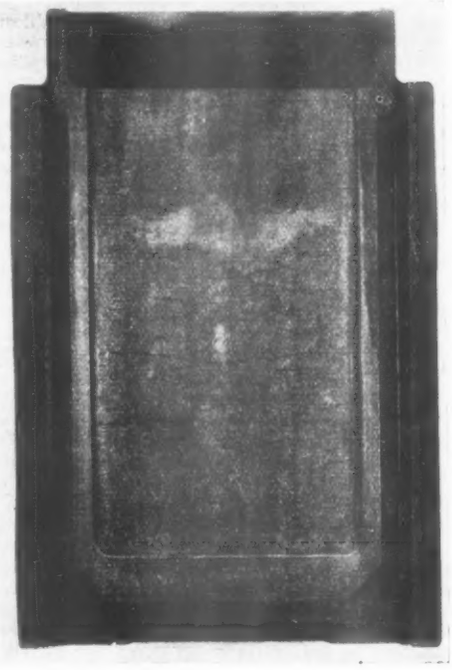

Fig. 16.—Inner Face of Grey Cast-Iron Ingot Mould after Approximately 100 Heats. × $\frac{1}{4}$.

Since in ferrous metals the thermal conductivity is low a material of this type satisfactory for moulds should have a high yield point. Nickel-chromium-molybdenum steel heat-treated

to give about 55 tons per sq. in. yield point at ordinary temperatures would appear to be a promising ferrous material in view of its high yield point over the range of temperatures in which warping occurs. At the other extreme copper is outstanding as a metal possessing high thermal conductivity and a low elastic limit, offering a combination of two desirable properties.

Small-scale tests using moulds built up of loose plates were made for preliminary trials under particularly severe conditions of various materials selected on these considerations. 70 : 30 brass was cast into these moulds and mild steel, included for comparative purposes, was found to warp considerably in either thick or thin sections after a single heat. Copper plates showed negligible distortion after 13 heats, while heat-treated nickel-chromium-molybdenum steel warped only slightly after 25 heats. A pure aluminium plate was tested in view of its intermediate thermal conductivity between steels and copper, and was actually found to warp only slightly after 5 heats. This material, however, was unsuitable for casting brass owing to a slight tendency to fusion at the point of impact of the stream.

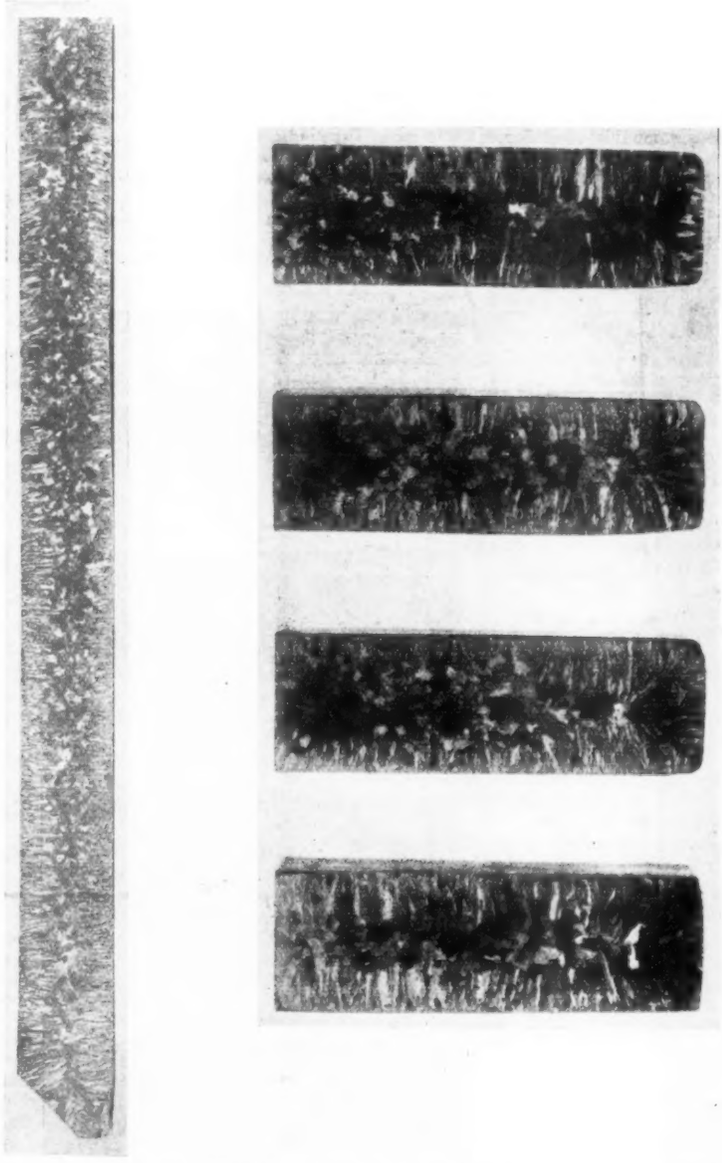

Fig. 17.—Structure of 70:30 Brass Ingot Cast in Grey-Iron Mould coated with Lampblack.

Testing of Ingot Moulds of Selected Materials.

Copper and heat-treated nickel-chromium-molybdenum steel having proved comparatively free from warping in the small-scale tests, moulds of these metals were constructed to give brass ingots 24 in. × 6 in. × 1½ in. of 70-lb. weight. The copper mould was built up from plates of rolled electrolytic copper 1.5 in. thick. Using a heavy stream of metal (70 : 30 brass) the alloy steel mould was found to show a tendency to weld on to the ingot—which tendency was only overcome by aluminising the inner surface. The copper mould was not subject to this difficulty. In each case a considerable number of ingots was cast in these moulds without any serious distortion. This success of the special steel and copper moulds provided an interesting confirmation of the earlier conclusions which had been drawn, but from the economic point of view the copper alone constitutes a practicable proposition as the aluminised and heat-treated special steel mould is somewhat costly.

Discussion of Results.

Determination of the temperature gradients in the walls of ingot moulds for casting 70 : 30 brass strips have shown that with ferrous materials, the inner surface of the mould is heated rapidly to a high temperature immediately after pouring. About 10 seconds after the completion of pouring, *i.e.*, approximately the stage of complete solidification of the ingots dealt with in this work, the temperature of the surface layer falls again while the main body of the mould becomes hotter. A similar maximum temperature, rapidly attained and maintained for a short space of time, has been observed in ingot mould walls by other workers. The Heterogeneity Committee of the Iron and Steel Institute in their Fourth Report show that the inner face of the mould in which a 38-cwt. steel ingot was cast attained a maximum temperature of 7 to 10 minutes after casting. Matuschka similarly gives evidence of a small peak in the temperature of the inner layers of the mould wall some 2 to 3 minutes after pouring. The explanation of this peak accepted by these workers is that it corresponds to the point at which the ingot shrinks away from the mould face and the sudden change in the direction of the curves in the present work may be due to the same cause.

In few observations of previous workers is the rapid rise and fall of the temperature of the inner surface layer of a cast-iron mould shown so clearly as in the present work. This is considered to be due to the fact that measurements have not been made sufficiently closely to the inner face of the mould. Roth, for instance, measuring the variations in temperature in iron moulds when casting brass, obtained slight evidence of this change in direction of the heating curves in only one instance, as his measurements were made no nearer than 5 mm. to the inner face of the mould. The rapid fluctations in temperature of the mould wall cause considerable stresses to be set up, which result in serious distortion of mild steels and transverse cracking of the inner faces of cast iron. Such distortion can be largely overcome in materials of low thermal conductivity by the use of alloys of high yield-point, but such a procedure is uneconomic for strip casting.

Copper as a mould material has been found to give successful results—its high thermal conductivity prevents the formation of steep temperature gradients and serious thermal stresses are therefore avoided. When pouring 70:30 brass at 110 deg. C. into a solid copper mould with walls equal in thickness to that of the cast strip, the maximum temperature recorded in the mould wall was of the order of 400 deg. C. This is of importance in considering the question of the welding of the ingot on to the mould. With ferrous alloys increasing the thickness of the wall does not affect the initial temperature of the inner face and will not therefore diminish welding tendencies. With copper, however, the uniformity of the temperature throughout the mould wall means that, under the conditions of those experiments, conduction of heat through the mould keeps pace with the rate of heat input. Increasing the thickness of the mould wall therefore would be expected, other things being equal, to decrease the maximum temperature attained. These experiments with copper moulds have been made with a vertical stream of brass. Pouring in such a manner that the stream impinges on the mould wall may be expected to cause a higher local temperature and with alloys with higher melting point may cause adhesion to the solid copper mould.

Water-cooling of a copper mould is also successful in preventing adhesion, the effect being to maintain the temperature throughout at a comparatively low level. It is clear that, from the point of view of maintaining a low temperature on the inner face of the mould, water cooling can only be advantageously applied to a material of high thermal conductivity such as copper, and would be of little use if applied to steel.

The Influence of the Mould Material on the Properties of the Cast Ingot.

Ingots of 70:30 brass were poured under standard conditions in each of the following moulds and examined for surface quality, structure and soundness.

	Size of ingot.	Mould walls thickness.
	In.	In.
Grey cast iron	12 × 6 × 1	1½
Water-cooled copper ..	12 × 6 × 1	½
Heat-treated Ni-Cr-Mo steel	24 × 6 × 1½	1¼
Solid copper	24 × 6 × 1½	1½

Both inert and volatile (graphite and oil) mould dressings were used, other conditions of pouring being the same. In each casting the metal was poured at 1,100 deg. C. in a single stream, giving a rate of rise of metal in the mould of 1.2 to 1.5 in. per sec. The mould was preheated to 80 to 100 deg. C. and was used vertically.

Ingot Surface.

Little variation was observed in the surface qualities of the ingots with different mould apart from small amounts of blowing from the cast-iron mould when using inert dressings. Where mould dressings were thin, the surface chill with the copper moulds was somewhat greater than with the others, resulting in fine laps on the ingot surfaces. These, however, were avoided when a moderately thick mould coating was used.

Soundness.

Density determinations were made on representative whole 12-in. by 6-in. by 1-in. ingots and on longitudinal half-sections of each large ingot. The results calculated to percentage cavities in the whole ingot are given in Table V.

Table V.—*Influence of Mould Material on Soundness of 70 : 30 Brass Ingots.*

Ingot mould.	Size of ingot.	Percentage cavities in whole ingot.	
		Non-volatile dressing.	Volatile dressing.
	In.		
Grey cast iron	12 × 6 × 1	0.38	0.31
Water-cooled copper ..	do.	0.27	0.29
Ni-Cr-Mo steel	24 × 6 × 1½	0.63	—
Solid copper ..	do.	0.69	—

The figures show little variation for any one size of ingot except that the water-cooled copper mould castings are slightly sounder than castings of the same size in the cast-iron moulds.

Ingot Structure.

The structure of ingots cast in the different moulds under comparative conditions varied but little. Where an inert mould dressing was used, the crystals were mainly columnar with only a small central zone of equiaxed structure. In the small ingots the water-cooled copper mould appeared to increase somewhat the length of the columnar crystals (cf. Figs. 17 and 18), but little difference was observable between the structures of the large ingots cast in solid copper or alloy steel moulds. The use of a volatile mould dressing produced an altogether different structure with all types of ingot mould—the ingots consisting almost entirely of fine equiaxed crystals. This effect which has been previously noted by Genders,[9] is due to the turbulence set up during the initial period of solidification by the volatilisation of the dressing, and is of far greater magnitude than the differences due to the material of the mould.

Reviewing these results, it would appear that, from the point of view of ingot surface, moulds of solid copper, water-cooled copper and alloy steel give brass of higher quality than moulds of cast iron. None of these alternative materials showed liability to produce defects in the ingot by "blowing" or warping. The effect of the mould material on the ingot structure was slight, water-cooled copper producing only a slight increase in columnar crystallisation compared with cast iron.

Effect of Nature of Mould on the Speed of Solidification of the Ingot.

In connection with this work, it is of interest to refer briefly to some small-scale measurements that were made on the speed of solidification of 70:30 brass in small moulds of different types.[10] The ingots used were (*a*) a small truncated cone 4 in. long by 2 in. in diameter at the top, and (*b*) a cylinder 6 in. long by 1.5 in. in diameter. In each case measurements of the solidification period of the centre of the ingot were made using moulds of different materials and wall thicknesses. Some typical results are given in Table VI. Measurements were also made of the effect of the initial temperature of the thick-walled steel mould on the solidification period. The results are shown in Fig. 19.

Table VI.—*Solidification Speed of 70 : 30 Brass Ingots Poured in Different Moulds.*

Mould.	Dressing.	Mould temperature. Deg. C.	Solidification period. Secs.
Conical ingots—			
Thick cast iron	lampblack	150	17
Thick copper ..	do.	125	14
Thick steel ..	do.	180	15
do. ..	oxidised	180	16
Thin cast iron	lampblack	260	22
Dry sand ..	nil	100	153
Cylindrical ingots—			
Thick copper ..	lampblack	120	16
Thin cast iron	do.	120	22
Thick steel ..	oxidised	810	145
Dry sand ..	nil	120	310

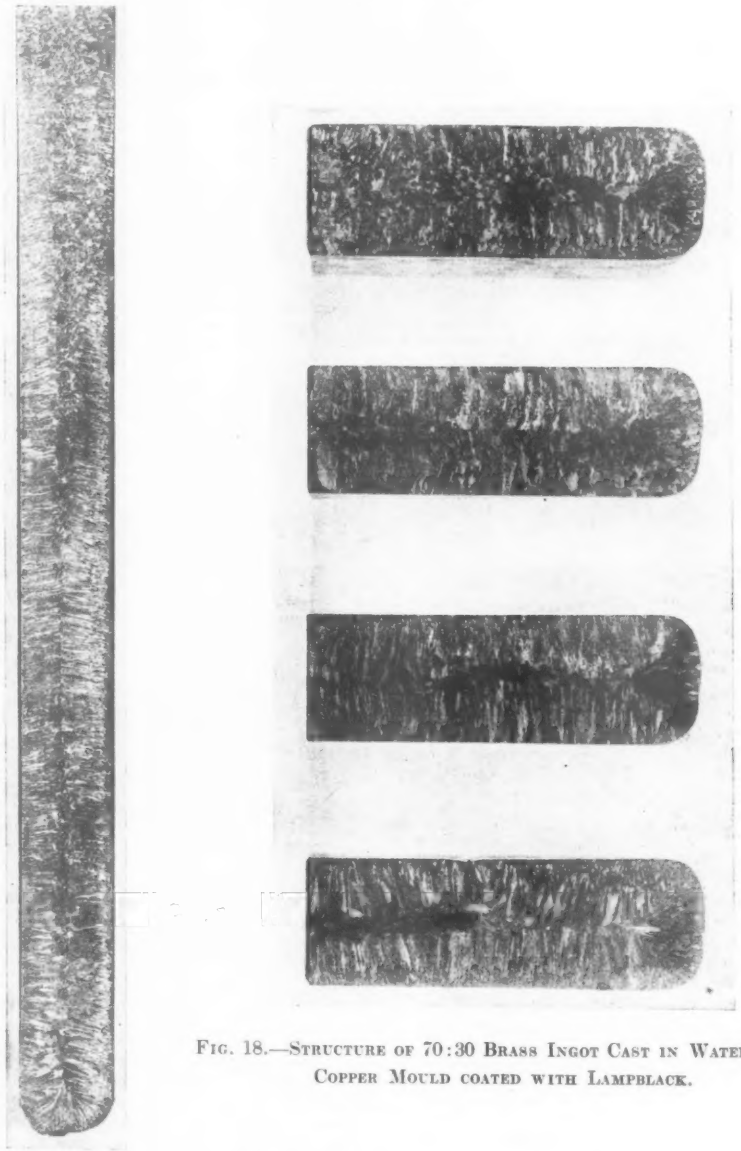

Fig. 18.—Structure of 70:30 Brass Ingot Cast in Water-Cooled Copper Mould coated with Lampblack.

The results obtained with these small castings provide a guide to the influence of the mould on the solidification of small brass ingots which is helpful in considering the major results obtained with strip ingot moulds.

That the use of a copper mould does not give a greatly increased speed of solidification as compared with cast iron is in agreement with the small influence on ingot quality noted in considering the larger strip moulds. It is evident

9 "J. Inst. Metals," 1930, 43, 187.

10 "The Influence of Dissolved Gases on the Soundness of 70 : 30 Brass Ingots," "J. Inst. Metals," 1928, 39, 191.

that heat transfer from metal to mould is dependent on other factors than thermal conductivity of the mould, such as the interference offered by the discontinuity at the metal-mould interface. Decreasing the thickness of mould wall in cast-iron moulds from an area ratio of 4:1 to 1:1 also had little effect on the time of solidification. Cast-iron moulds ordinarily used in brass strip castings are of the order of 1.5 in. in thickness, but this thickness is necessary, as thin walled moulds quickly deteriorate in use. Any increase in thickness beyond about ¼ in. may be regarded almost entirely as having the purpose of increasing the life of the mould. Variation of the temperature of the mould within the practicable limits similarly has no noticeable effect on the solidification period of the ingot. It is interesting to note in this connection that Courty,[11] investigating the "flowability" of aluminium alloys in a metal spiral mould, found that variations in the temperature of the mould had little effect on the length of spiral until the melting point of the metal was approached. His curve for length of spiral: mould temperature was similar in type to that shown in Fig. 19.

It must be emphasised that these remarks apply solely to ingots of about 1 in. in thickness, cast in moulds of the usual size, and that, when considering ingots of appreciably different type or size, great care must be employed in utilising these results.

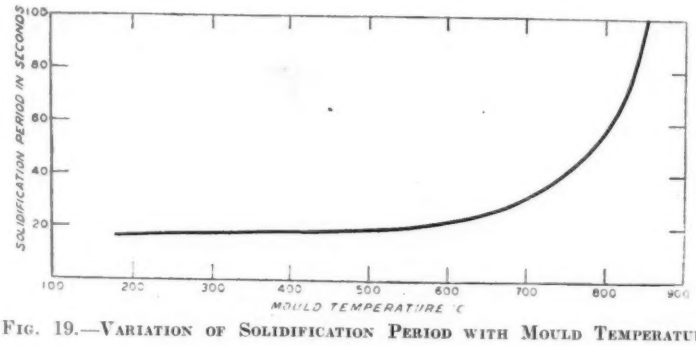

FIG. 19.—VARIATION OF SOLIDIFICATION PERIOD WITH MOULD TEMPERATURE.

General Summary and Conclusions.

Grey cast iron has long been regarded as the most suitable available material for moulds for non-ferrous strip ingot casting, and it has not been generally realised that, while cast iron possesses many advantages, it is capable of introducing ingot defects, the source of which has frequently remained unexplained or has been attributed to other causes. When the face of a cast-iron mould is unduly heated during casting, either by the use of a high initial mould temperature or by prolonged impingement of the stream of metal, the surface of the ingot may show groups of roughly circular holes penetrating to a considerable depth. It has been shown that this effect, commonly termed "blowing," is due entirely to the evolution from the mould surface of gases produced mainly by a reaction between the combined carbon in the iron and the film of oxide in the mould surface. This reaction has been found to occur readily above 700 deg. C., a temperature frequently reached by some portions of the face of an iron mould immediately after casting. Blowing may also be produced to a slight extent by reaction of the graphite of the cast iron with oxide or by the expansion of air either absorbed by the graphite or in cavities in the metal. Other ferrous alloys, such as steels of high carbon content, may evolve gases in a manner similar to that of cast iron owing to the same oxide-carbide reaction. While surface protections such as refractory washes or electro-deposited coatings are capable of avoiding the production of "blowing," such measures are not a sufficiently permanent remedy for general adoption in practice.

It would appear, therefore, that to eliminate the risk of "blowing," a mould material is required containing very little carbon, and from this point of view, low carbon steel and certain non-ferrous metals have proved suitable materials for moulds. A further source of defects in brass ingots made in moulds of cast iron is the transverse cracking which inevitably occurs on the face of the mould at a certain stage, frequently early, in its life. The cracks eventually develop to an extent entailing the scrapping of the mould. This is due to the stresses arising from the repeated unequal heating and cooling of the mould and probably occurs more readily in low-quality cast iron of high phosphorus content than in high-quality hematite irons and "semi-steel" or other special close-grained irons.

Mild steel, while not possessing the disadvantages of "blowing" and cracking, has been found to be unsuitable as a mould material, since, after brief use, the mould becomes permanently deformed. This effect is due to thermal stresses arising from a steep temperature gradient in the wall and is therefore similar in origin to the cracking of cast-iron moulds. With a material of high thermal conductivity, such as copper, the temperature gradient through the mould wall during casting remains relatively small, and warping is not found to occur to any appreciable extent. No other metal possesses more favourable properties in this respect than copper except pure silver. Aluminium, while having a fairly high thermal conductivity, has too low a melting point to be suitable for brass casting moulds. For the casting of metals of low melting point, however, such as alloys of aluminium and of zinc, aluminium may be a satisfactory material for moulds.

The successful use of copper for non-ferrous ingot casting moulds will depend on the provision of means for preventing the mould from rising in temperature during casting to a point involving risk of the welding on of the ingot. Accordingly the mould may be one of small thickness, water-cooled on the outer faces, or may be of solid copper of adequately large section. For brass a solid mould is satisfactory—a copper mould giving a brass ingot 24 in. by 6 in. by 1½ in. dimensions should have a minimum wall thickness of 1.5 in. For alloys of high melting point water-cooled moulds are necessary—in some cases special design of the mould is essential to avoid adhesion (cf. Rohn). It has been confirmed experimentally that in a copper mould the rate of solidification of a brass ingot of thin section and its consequent structure and properties are not appreciably affected whatever method is adopted for the absorption of heat conducted from the mould faces; water cooling may therefore be considered to have little relation to the quality of the ingot, its function being to prevent overheating of the mould and to facilitate rapid production.

Ingot moulds free from warping can be made from a material having a sufficiently high elastic limit (at both low and raised temperatures) to avoid plastic deformation under the thermal stresses induced during casting. Experimental trials have shown that a mould of nickel-chromium-molybdenum steel, suitably heat-treated, is satisfactory in this respect, but is subject to other disadvantages and is somewhat costly. From all points of view, therefore, it is considered that copper is the most suitable material for brass strip ingot moulds, either as a solid mould of slightly greater thickness than the cast-iron moulds at present in use, or as a thinner water-cooled mould. The use of copper moulds obviates the surface difficulties associated with cast iron, while affecting the structure and soundness of the ingots but little.

Acknowledgments.

In conclusion, the author wishes to thank the Council of the British Non-Ferrous Metals Research Association for granting their permission for the publication of this Paper, and Dr. L. Northcott for much assistance in the experimental work.

11 "Compt. rend.," 1930, 190, 936.

Bombay Iron and Steel Trade.

(FROM OUR INDIAN CORRESPONDENT.)

The report on the seaborne trade of Bombay for the year 1931-32, recently published by the Government, states that in regard to the iron and steel business, in spite of the extraordinarily low prices, demand was much restricted on account of large stocks held.

The total imports from the United Kingdom further fell from 47,000 tons to 38,000 tons. Those from Belgium fell from 83,000 tons to 50,000 tons. Arrivals from Germany, France and the United States also declined, but those from Luxemburg improved from 8,000 tons to 9,700 tons.

A comparison of imports of protected articles of iron and steel with those of the preceding year shows a further falling off, under galvanised sheets, from 45,000 tons to 31,000 tons, due to smaller arrivals from the United Kingdom and Belgium, and also under metal sleepers and keys, owing to smaller receipts from Belgium. Imports of beams, channels, pillars, girders and bridgework also decreased by 7,700 tons to 12,000 tons, and those of rails, chairs and fishplates by 5,600 tons to 300 tons only. Those of sheets and plates not galvanised or tinned declined by 2,700 tons to 6,750 tons, mainly owing to smaller receipts from the United Kingdom and Belgium. Arrivals of bars, other than cast steel, also declined. Supplies of these from Belgium fell from 11,000 to 8,000 tons, but those from Luxemburg rose from 4,500 tons to 7,700 tons.

The total imports of machinery were reduced, all kinds of machinery, except textile, oil-crushing and refining machinery, sharing in the fall. The share of the United Kingdom, however, which is by far the largest supplier, remained unchanged.

Fusion Welding as Related to Steel Castings.

(*Concluded from page* 168.)

tions as to composition, coating and diameter of rod; amperage of current; position and character of electrode; design of fillet connection; pressure and admixture of gas; nature of burner tip; and other factors that determine the quality of weld metal. These welding experts have also obtained and published valuable information regarding the best practices to employ when welding numerous varieties of alloy steel, including those in the high-alloy classification. There is, all told, much information available in current literature on this interesting subject. It is natural that most of it should have significance particularly for those who depend on or contemplate fabrication in uniting rolled-steel parts by fusion. If the author has been able to throw light on the subject of welding as related to the product of the steel foundry, he will have accomplished his purpose, especially if his contribution should prompt others to contribute information through the discussion of this Paper.

This Week's News in Brief.

Trade Talk.

INDUSTRIAL METAL PRODUCTS, LIMITED, is being wound up voluntarily. Mr. Charles Latham, 78, New Oxford Street, London, W.C.1, is the liquidator.

ONE OF THE BLAST-FURNACES of Messrs. M. & W. Grazebrook, Limited, Netherton, Dudley, was re-started on September 14, after having been closed since February.

A £5,000,000 PROGRAMME of railway construction is to be started by the Argentine Government to reduce unemployment, according to a message from Buenos Aires. About 500 miles of new track are to be laid down, it is stated.

MRS. LILIAN SHIRLEY KNOTT (wife of John Henry Knott), iron and brass founder, carrying on business as the Crown Street Foundry Company, at Crown Street, Wolverhampton, is paying a first and final dividend of 1s. 4½d. in the £.

THE DIRECTORS of the Metal Box Company, Limited, propose to increase the capital to £2,050,000 by the creation of 50,000 7 per cent. cumulative preference shares of £1 each ranking in all respects with the existing preference shares.

THE UNITED STEEL COMPANY, LIMITED, have extended an invitation to the Junior Section of the Lancashire Branch of the Institute of British Foundrymen to visit their works, "The Ickles," Sheffield, on Saturday, September 24.

THE PULSOMETER ENGINEERING COMPANY, LIMITED, Reading, have received an order from the Hadleigh Urban District Council for supplying three sets of crude-oil engines and centrifugal pumps, two of which are to be provided with automatic starting and stopping switchgear at the pumping station.

THE OPENING MEETING of the Chemical Engineering Group of the Society of Chemical Industry will be held on Monday, October 3, at 8 p.m., in the rooms of the Chemical Society, Burlington House, Piccadilly, W.1, when Dr. G. D. Bengough will deliver the Jubilee Memorial Lecture on "The Corrosion of Metals in Salt Solutions and Sea Water."

AT THE FORTHCOMING EXHIBITION at Copenhagen stands have been taken by Messrs. Dorman, Long & Company, Limited; Vickers, Limited; Marshall Sons & Company, Limited; Ferguson Pailin, Limited; Babcock & Wilcox, Limited; the Stanton Ironworks Company, Limited; Thomas Firth & John Brown, Limited; the Ford Motor Company, of Dagenham; and the Sheffield Steel Products, Limited.

IN THE COURSE of an appeal on behalf of the Summerlee Iron Company, Limited, Coatbridge, against the assessments of the ironworks and chemical works, Mr. D. M. Mowat, the general manager, said that the whole works were idle and that there was no economic demand for pig-iron in Scotland. The future prospects of the Scottish pig-iron industry were black, and their Continental competitors could undersell them in every branch. The Court delayed coming to a decision for a week.

SATISFACTORY PROGRESS IS being made with the work of preparing a scheme for the reorganisation of the iron and steel industry. The National Committee appointed at the request of the Import Duties Advisory Committee has been meeting at regular intervals, and good progress is also being made by the Regional and Special Industries Committees. The National Committee hopes by the end of the month to present a report to the Advisory Committee showing in detail the work which has been done.

ELECTROLUX, LIMITED, the well-known manufacturers of domestic labour-saving and health-preserving appliances, have decided to extend their Luton works, to build new offices and to increase productive capacity by utilising for manufacturing purposes and space occupied by the present offices. The scheme also provides for the erection of a receiving depôt and raw materials store, as well as an extension to the finished stores, which will accommodate some thousands of the company's products. The work is being expedited as much as possible, and the new building is expected to be completed in about five months' time.

THE LONDON BRANCH of the Institute of British Foundrymen have arranged a visit to the Ford Motor Company's works at Dagenham. Owing to the large numbers, it has been arranged for two separate parties, one to visit the works on September 29 and the other on October 3. The arrangement for both dates is that the party will meet outside the Ford Motor Company's office at Dagenham, Essex, at 2 p.m. Members travelling by rail from London are recommended to go by the train leaving Charing Cross (Underground District Railway) at 12.55 p.m. and book to Heathway Station. This train arrives there at 1.38 p.m. Passes have been provided and will be issued at the works, and it will not be possible to get any additional passes at the works on the day of the visit.

The transmission towers which have been erected for the Central Electricity Board at Horseshoe Corner, Dagenham Dock, and near the L.C.C. Sewage Outfall Works are now complete. These two crossing towers are the highest in Europe, being 487 ft. high, and have a base width of 120 ft. The towers will carry two circuits, each of three cables operating at 132,000 volts, and will form the connecting link over the River Thames between the Board's grid system in Essex and that in Kent. The weight of each of the towers above ground is about 280 tons, while the weight of the anchor towers above ground level is about 24 tons each. The towers have been designed to withstand a maximum working tension on the crossing tower of 25,650 lbs., while the conductors have an ultimate strength of 57,600 lbs. The total weight of the conductors is about 19¾ tons. Each crossing tower will be lighted by means of illuminated crosses located at points one-third and two-thirds of the height of the towers. The apex of the towers will also be equipped with lights.

DR. VAN DER BYL, in a Paper read before the Johannesburg branch of the Economic Society of South Africa, spoke optimistically of the future of the new iron and steel works at Pretoria. He declared that, even with the present low prices, the works, if established, would be able to carry on at a profit. He emphasised the fact that the consumption of steel in South Africa was approximately three times as large as was necessary for the establishment of a steelworks in Pretoria of sufficient capacity to operate on modern lines. It was the intention to man the works with white labour, with possibly a few exceptions, the estimates of production being based on white-labour policy entirely. The South African Iron and Steel Industrial Corporation, Dr. van der Byl said, was not unmindful of the difficulties that would be experienced in selecting a suitable labour force, and to minimise those difficulties as much as possible, work had already been started in framing a system of intelligence testing, mechanical-aptitude testing and the training to which applicants would be subjected.

Obituary.

MR. CLEMENT FIRTH, of Park Road, Basford, Stoke-on-Trent, the melting manager, was killed on Monday through a fall of staging at the Shelton Iron, Steel & Coal Company's Works at Etruria, Stoke-on-Trent.

MR. STANLEY CYRIL ELSE, of Sheffield, died suddenly last week, aged 44. Mr. Else, who was the son of Mr. H. C. Else, was well known in industrial circles, having been associated first with Messrs. Hadfields, Limited, then with Messrs. William Cooke & Company, Limited, as director, until 1930, and since with the Templeborough Rolling Mills, Limited. He was severely wounded during the war.

MR. ALEXANDER WALKER, who was widely known in foundry and engineering circles in the West of Scotland, died at his residence, "Gowanbank," Milngavie, on September 13. Mr. Walker was for many years associated with the Gowanbank Foundry Company, where his duties brought him into intimate contact with the Scottish iron industry. He took an active interest in the Glasgow and West of Scotland Association of Foremen Engineers and Draughtsmen, a society of which he was President a few years ago, since when he has served as a member of the Council. About 10 years ago Mr. Walker became connected with the firm of Wallace (Glasgow), Limited, agricultural implement makers when they took over the war-time factory of W. Beardmore & Company, at Cardonald.

Personal.

MR. ADAM HUNTER, owing to ill-health, has resigned from the board of Messrs. Sir William Arrol & Company, Limited, but will retain the position of consulting engineer to the firm.

MR. D. MORGAN REES, J.P., is President-Elect of the South Wales Institute of Engineers for 1933, and will be installed at the January meeting at Cardiff. Mr. Morgan Rees, who has been a member of the Institute for 36 years, is head of Messrs. D. Morgan Rees & Sons, Limited, wire-rope manufacturers, of Whitchurch, Cardiff.

M. LUIS BARREIRO (manager of the Morro Mining Company, of Bilbao), a member of the Iron and Steel Institute, has been elected President of the Iron, Steel and Allied Trades Association in Spain. It will be recalled that M. Barreiro acted as hon. secretary of the Executive Committee in connection with the visit of the Iron and Steel Institute to Spain in 1928.

Wills.

MR. THOMAS C. STEWART, Mount Street, W., and late of Skelmorlie, former managing director of Stewarts & Lloyds, Limited	£106,491
HODGSON, R. T., of Stockton-on-Tees, director of Messrs. Blair & Company (1926), Limited, engineers, and connected with iron and steel firms on Tees-side	£18,694

Company Reports.

Steel Company of Canada, Limited.—Quarterly dividend of 43¾ cents per share on the common stock.

Coltness Iron Company, Limited.—Interim dividend on the ordinary shares of 3 per cent., actual, less tax.

Head, Wrightson & Company, Limited.—No preference dividend will be paid for the half-year ending September 30.

Imperial Chemical Industries, Limited.—Interim dividend of 2½ per cent. actual on the ordinary capital, less tax.

Platt Bros. & Company, Limited.—No interim dividend on the 4½ per cent. or 7 per cent. cumulative preference shares.

Harland & Wolff, Limited.—Trading loss for the year ended December 31 last of £283,136, without provision for depreciation.

London Foundry Classes.

The recently-opened South-East London Technical Institute, Lewisham High Road, London, S.E.4, is including foundry practice amongst the classes scheduled for evening study this winter. Foundry science, held on Wednesdays from 7 to 9.30 p.m., is under the capable direction of Mr. G. C. Pierce, a Past-President of the London Branch of the Institute of British Foundrymen. Practical foundry work is taught on Mondays by Mr. F. C. Cotten; Metallurgy by Mr. F. A. Ruddock on Thursdays; and Drawing and Calculations by Mr. W. Chester on Fridays. We wish every success to this new venture.

Scottish Branch I.B.F.

The opening meeting of the session of the Scottish Branch will be held in the Royal Technical College, Glasgow, on October 1. Mr. H. D. Campbell, the newly-elected President, will deliver his address, and the Paper on mechanical sand-handling in the foundry, for which Mr. Robert McNab was awarded the John Surtees Gold Medal, will be read by Mr. Evan Ross, a late colleague of the author, who has left to take up a position in Singapore. At the conclusion of the meeting the members, with their ladies and friends, will meet at a social gathering in the Cadora Restaurant, Glasgow.

A New Magnesium Alloy.—An alloy, developed by the American Magnesium Corporation of Pittsburg, and stated to possess good casting and corrosion-resisting properties consists of Mg 91.0, Sn 6.0, Cd 1.0, Zn 1.0 and Mn 1.0 per cent.

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Raw Material Markets.

The recent spurt of prompt buying in the iron and steel markets has partly died away, but the atmosphere remains more favourable to forward contracting. A steady, if limited, trade is being done in pig-iron, but few of the many inquiries for finished steel have so far resulted in orders. Home producers of both finished and semi-finished steel material are benefiting by the strengthening of Continental quotations.

Pig-Iron.

MIDDLESBROUGH.—A steady local trade is being done, although there has been a slight reaction from the busy period experienced at the beginning of the month. Orders continue to trickle in from overseas, several sales having been made to Continental consumers who had hitherto been taking their supplies from elsewhere. The producers continue to make low quotations to Scottish consumers, who are using cheap Indian and other brands, the local quotations remaining unchanged at:—No. 1 Cleveland iron, 61s.; No. 3 G.M.B., 58s. 6d.; No. 4 foundry, 57s. 6d.; No. 4 forge, 57s., f.o.t. or f.o.b.

Both home and export demand for East Coast hematite is showing steady expansion, and hopes are expressed that there may shortly be some reduction of the considerable stocks at present held by the makers. A pleasing feature of the export situation is the increasing trade being done with Italian consumers, to whom good shipments of hematite have recently been made. Ordinary East Coast brands remain at 60s., with No. 1 quality at 60s. 6d.

LANCASHIRE.—New bookings remain at a low level in this area, as do deliveries into consumption, and the position, for this season of the year, is regarded as very unsatisfactory. The inactivity at the cotton mills, is, of course, having some effect on the situation, but the most weakening feature continues to be the competition of large supplies of cheap scrap material. For delivery to works in the Manchester district, current offers of Derbyshire, Staffordshire and Cleveland No. 3 foundry iron are maintained at 67s per ton, Northamptonshire being quoted at 65s. 6d., Derbyshire forge at 62s., and West Coast hematite at around 81s. Scottish No. 3 is on offer at the reduced rate of 82s. 6d., delivered Manchester, but there is a wide margin between this quotation and the price at which competitive Indian iron is obtainable.

MIDLANDS.—There is no change in the position of the consuming industries in this area. Although the light foundries continue to experience moderate activity, the heavy engineering trades are very poorly employed. Prices are without alteration, the controlled figures being 62s. 6d. for Northants No. 3 and 66s. for Derbyshire, North Staffordshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations.

SCOTLAND.—There has been little response to the recent reductions in prices, few consumers being in the position to buy. Scottish No. 3 foundry iron is at 67s. 6d. per ton, f.o.t. furnaces, with 2s. 6d. extra for No. 1. Middlesbrough No. 3 is still quoted at 55s. 6d. at Falkirk, and Midlands iron at about 54s. at Falkirk.

Coke.

There are no new developments in the foundry-coke market, consumers adhering to their policy of hand-to-mouth buying. Best Durham fuel is at between 36s. 9d. and 38s., with inferior grades at 34s. to 35s., delivered Birmingham. Welsh coke is on offer, according to the analysis required, at from 30s. to 45s. per ton, delivered Birmingham and district.

Scrap.

Business has receded slightly in the Cleveland scrap-iron market, but the tone remains firm, and sellers are not inclined to enter into forward contracts at present rates. In the Midlands, conditions remain irregular in the foundry trade. There has been a rather better demand for light cast-iron scrap, but prices are generally unchanged. In South Wales, the price of heavy cast iron has fallen to 41s. to 42s. per ton, owing to the weak demand. In Scotland, there has been a better demand, the prices of ordinary cast iron and heavy machinery metal rising to 40s. and 46s. 6d. per ton respectively.

Steel.

Sentiment remains strong in the steel markets. The amount of business transacted shows an improvement compared with the volume in the first half of the year, according to the official report of the London Iron and Steel Exchange. Many of the export markets are showing more interest than for several months past, but owing to restrictions upon exchange and other difficulties the business passing is confined to comparatively small lots. These are sufficient, however, to indicate that a substantial demand exists, which, owing to the restrictions, cannot be satisfied. In the semi-finished steel department, business has been comparatively light, as most of the consumers hold considerable stocks and confine their purchases to small quantities. The fresh advance in the price of Continental material has diverted a considerable amount of business to British makers, and most of the orders going to the Continent from this country are almost entirely for near delivery. In the finished-steel section conditions appear to have improved, although the demand remains well below normal. Both on home and export account buying has been fairly active and shows a tendency to expand.

Metals.

Copper.—The market has partially recovered from the recent sudden drop, during which numerous consumers were reported to have renewed their stocks, but there is little demand at the moment and there is a general atmosphere of "awaiting developments." Deliveries into consumption on the Continent have this year fallen by about 20 per cent., compared with 1931, while in Great Britain alone deliveries have only fallen by about 10 per cent.

Closing quotations :—

Cash.—Thursday, £33 5s. to £33 7s. 6d.; Friday, £34 to £34 2s. 6d.; Monday, £32 13s. 9d. to £32 15s.; Tuesday, £32 17s. 6d. to £33; Wednesday, £34 15s. to £34 16s. 3d.

Three Months.—Thursday, £33 2s. 6d. to £33 3s. 9d.; Friday, £34 to £34 2s. 6d.; Monday, £32 13s. 9d. to £32 15s.; Tuesday, £32 17s. 6d. to £33; Wednesday, £34 13s. 9d. to £34 15s.

Tin.—There continues to be a steady, if limited, demand for tin in this country. Consumption of this metal should show further increase in the future, as the consuming industries are reported to be better placed now than for some months past. The tinplate market, in particular, has experienced considerable buying, both from home and overseas, and the producers will shortly be coming into the market for further supplies of raw material.

Official closing prices :—

Cash.—Thursday, £149 10s to £149 15s.; Friday, £151 12s. 6d. to £151 17s. 6d.; Monday, £147 2s. 6d. to £147 5s.; Tuesday, £149 10s. to £149 15s.; Wednesday, £151 15s. to £152.

Three Months.—Thursday, £151 5s. to £151 10s.; Friday, £153 5s. to £153 10s.; Monday, £148 17s. 6d. to £149; Tuesday, £151 5s. to £151 10s.; Wednesday, £153 10s. to £153 15s.

Spelter.—When the recent fall in metal prices took place, many galvanisers took the opportunity of reinforcing their stocks, there having been increased activity in the consuming trade. A fair demand still continues, and, with the further improvement in the statistical position, it must be acknowledged that the outlook is distinctly more promising.

Daily fluctuations :—

Ordinary.—Thursday, £14 15s.; Friday, £15 5s.; Monday, £15; Tuesday, £15 5s.; Wednesday, £15 7s. 6d.

Lead.—Consumers in this country continue to support the market, but there is little response from the Continent, where the lead-consuming industries are experiencing very bad conditions. Full stocks of this metal are held, and no difficulty is experienced in getting supplies at the current quotations.

This week's prices have been :—

Soft Foreign (Prompt).—Thursday, £12 11s. 3d.; Friday, £12 18s. 9d.; Monday, £12 13s. 9d.; Tuesday, £12 13s. 9d.; Wednesday, £12 18s. 9d.

Notes from I.B.F. Branches.

Lancashire.—On the afternoon of Saturday, September 10, about 200 members of the Lancashire Branch assembled at the works of Messrs. Craven Brothers, Stockport, and were conducted round the various shops in parties of about 14. The members assembled in the Club Room for tea at 5 o'clock.

Amongst those present were Mr. Roy Stubbs, Vice-President of the Institute of British Foundrymen; Mr. Ellis Flower, Branch-President; Mr. T. Makemson, Secretary, and Mr. Cook, Hon. Branch-Secretary.

After tea, Mr. Flower, after expressing the thanks of the Lancashire Branch of the Institute, mentioned that their host, Mr. F. Greenwood, the managing director of Craven Brothers, had long been associated with their Institute, whilst Mr. Longden, their foundry manager, was twice President of the Lancashire Branch. He spoke of the facilities offered to apprentices to-day to obtain a thorough practical and technical training, through the very well-equipped Junior Technical School at Openshaw, which included an instructional foundry.

Mr. Roy Stubbs, seconding the vote of thanks, spoke of the very interesting visit and made special reference to the well-equipped and well-lighted shops. He stressed the opportunities offered to local apprentices for technical training and also referred to the newly-equipped Junior Technical School at Openshaw.

Mr. Greenwood, on behalf of Craven Brothers, expressed pleasure that the visitors had enjoyed their tour of the works, and stated that they were amply repaid by the pleasure at seeing such a record gathering. He outlined the work of the Institute and stressed the usefulness of such visits. It was insufficiently realised that the Institute had been largely responsible for raising the foundry industry to its present high position in the engineering trades. Mr. Greenwood said he was proud to announce that he was one of the oldest members of the Lancashire Branch.

Mr. Makemson, in addressing the gathering, mentioned that there were special classes in Manchester for students to qualify for the City and Guilds Certificate, and stated that there were two members present who had obtained this certificate.

Publication Received.

Transactions of the Institution of Chemical Engineers, Vol. 9, 1931. Published by the Institution from Abbey House, Westminster, London, S.W.1.

This volume contains several Papers of interest to our readers. One, treating of the flow of gases at high pressures through pipes, has used copper and steel tube for the experimental work, certainly contains pointers for the manufacturer of cast-iron pipe. Another Paper presents a correlation of existing data on high-temperature insulation, whilst a third deals with the selection of ferrous materials for the construction of chemical plant. A very high standard of printing and illustrating has been maintained throughout the book.

The Sesci Furnace.

It has been pointed out to us that, whilst the Rex pulveriser installed in connection with the Sesci plant at the National Gas Engine Company, Limited, Ashton-under-Lyne, as stated in the article we printed in our issue of September 8, is rated at 30 h.p., it is envisaged for the operation of two such furnaces, and not one only, as might be deduced.

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F.T.J. 22.9.32.

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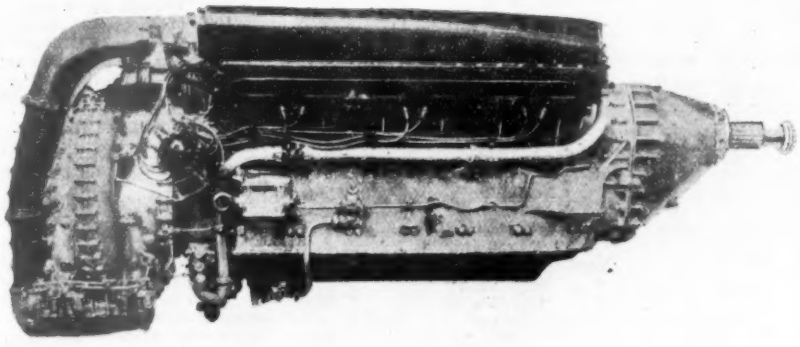

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WEEKLY PRICE CURRENT.

COPPER.

	£ s. d.
Standard cash	34 15 0
Three months	34 13 9
Electrolytic	38 0 0
Tough	35 0 0
Best selected	35 10 0
Sheets	68 0 0
India	46 0 0
Wire bars	37 15 0
Do., Oct.	38 0 0
Do., Nov.	38 0 0
Ingot bars	37 15 0
H.C. wire rods	40 10 0
Off. av. cash, August	31 9 $1\frac{12}{21}$
Do., 3 mths., August	31 6 $8\frac{24}{84}$
Do., Sttlmnt., August	31 8 $11\frac{5}{21}$
Do., Electro, August	35 2 $4\frac{7}{21}$
Do., B.S., August	33 15 $3\frac{1}{3}$
Do., wire bars, August	35 9 $1\frac{1}{21}$
Solid drawn tubes	10½d.
Brazed tubes	10⅜d.
Wire	7d.

BRASS.

Solid drawn tubes	9½d.
Brazed tubes	11½d.
Rods, drawn	8½d.
Rods, extd. or rlld.	5d.
Sheets to 10 w.g.	7⅞d.
Wire	7⅜d.
Rolled metal	7⅜d.
Yellow metal rods	4½d.
Do. 4 × 4 Squares	5½d.
Do. 4 × 3 Sheets	5½d.

TIN.

	£ s. d.
Standard cash	151 15 0
Three months	153 10 0
English	153 15 0
Bars	153 10 0
Straits	154 15 0
Australian	153 10 0
Eastern	153 5 0
Banca	156 10 0
Off. av. cash, August	142 2 $4\frac{7}{21}$
Do., 3 mths., August	143 12 $3\frac{1}{42}$
Do., Sttlmt., August	142 1 $1\frac{1}{21}$

SPELTER.

	£ s. d.
Ordinary	15 7 6
Remelted	15 0 0
Hard	12 10 0
Electro 99.9	17 10 0
English	16 0 0
India	14 15 0
Zinc dust	22 0 0
Zinc ashes	2 2 6
Off. aver., August	13 14 4½
Aver. spot, August	13 11 10½

LEAD.

	£ s. d.
Soft foreign ppt.	12 18 9
Empire	13 3 9
English	14 10 0
Off. average, August	11 9 4½
Average spot, August	11 6 $11\frac{19}{42}$

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 10 0
Do., V.M. ex-whse.	22 10 0
Rods	27 0 0
Boiler plates	23 0 0
Battery plates	—

ANTIMONY.

	£ s. d. to £ s. d.
English	35 0 0 to 42 10 0
Chinese	24 0 0
Crude	16 0 0

QUICKSILVER.

	£ s. d.
Quicksilver	9 17 6

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£8 0 0
45/50%	£13 15 0
75%	£19 10 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	10½d. lb.
Ferro-phosphorus, 20/25%	£21 0 0
Ferro-tungsten—	
80/85%	1/9 lb.
Tungsten metal powder—	
98/99%	2/- lb.
Ferro-chrome—	
2/4% car.	£34 5 0
4/6% car.	£25 15 0
6/8% car.	£24 10 0
8/10% car.	£22 5 0
Ferro-chrome—	
Max. 2% car.	£37 5 0
Max. 1% car.	£44 10 0
Max. 0.70% car.	£45 17 6
70% carbon-free	1/- lb.
Nickel—80/99.5%	£240 to £245
"F" nickel shot	£216 0 0
Ferro-cobalt	7/9 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export (nom.)	£9 15 0
Metallic manganese—	
94/96% carbon-free	1/4½ lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{1}{16}$ in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£ s. d.	£ s. d.
South Wales—		
Heavy steel	1 18 6 to	2 0 0
Bundled steel and shrngs.	1 15 0 to	1 18 0
Mixed iron and steel	1 15 0 to	1 16 0
Heavy cast iron	2 1 0 to	2 2 0
Good machinery	2 5 0 to	2 7 6
Cleveland—		
Heavy steel	1 12 6	
Steel turnings	1 7 6	
Cast-iron borings	1 2 6	
Heavy forge	2 10 0	
W.I. piling scrap	2 2 6	
Cast-iron scrap	1 15 0 to	1 16 0
Midlands—		
Light cast-iron scrap	1 15 6	
Heavy wrought iron	2 2 6	
Steel turnings, f.o.r.	0 19 0	
Scotland—		
Heavy steel	1 13 0	
Ordinary cast iron	2 0 0	
Engineers' turnings	1 7 6	
Cast-iron borings	1 10 0	
Wrought-iron piling	2 0 6	
Heavy machinery	2 6 6	

London—Merchants' buying prices delivered yard.

	£ s. d.
Copper (clean)	24 0 0
Brass	17 0 0
Lead (less usual draft)	11 10 0
Tea lead	10 0 0
Zinc	7 10 0
New aluminium cuttings	74 0 0
Braziery copper	21 0 0
Gunmetal	18 0 0
Hollow pewter	82 0 0
Shaped black pewte	65 0 0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	60/6
Hematite M/Nos.	60/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	70/-
„ d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs No. 4 forge*	61/-
„ No. 3 fdry.*	66/-
Shrops basic	—
„ Cold blast, ord.	—
„ „ roll iron	—
Northants forge*	57/6
„ fdry. No. 3*	62/6
„ fdry. No. 1*	65/6
Derbyshire forge*	61/-
„ fdry. No. 3*	66/-
„ fdry. No. 1*	69/-
„ basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	70/-
„ No. 3	67/6
Hem. M/Nos. d/d	67/6
Sheffield (d/d district)—	
Derby forge	58/6
„ fdry. No. 3	63/6
Lincs forge	—
„ fdry. No. 3	63/6
E.C. hematite	73/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
„ fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	82/6
Clyde, No. 3	82/6
Monkland, No. 3	82/6
Summerlee, No. 3	82/6
Eglinton, No. 3	82/6
Gartsherrie, No. 3	82/6
Shotts, No. 3	82/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£ s. d. to £ s. d.
Bars (cr.)	9 5 0 to 9 15 0
Nut and bolt iron	7 15 0 to 8 10 0
Hoops	10 10 0 to 12 0 0
Marked bars (Staffs) f.o.t.	12 0 0
Gas strip	10 10 0 to 12 0 0
Bolts and nuts, ¾ in. × 4 in.	12 0 0
Steel—	
Plates, ship, etc.	8 15 0 to 8 17 6
Boiler plts.	8 7 6 to 9 5 0
Chequer plts.	10 7 6
Angles	8 7 6
Tees	9 7 6
Joists	8 15 0
Rounds and squares, 3 in. to 5½ in.	9 7 6
Rounds under 3 in. to ½ in. (Untested)	6 12 6 & up.
Flats—8 in. wide and over	8 12 6
„ under 8 in. and over 5 in.	8 17 6
Rails, heavy	8 5 0 to 8 10 0
Fishplates	12 0 0
Hoops (Staffs)	9 10 0
Black sheets, 24g.	8 0 0 to 8 10 0
Galv. cor. shts.	9 5 0 to 9 15 0
Galv. flat shts.	9 15 0 to 10 15 0
Galv. fencing wire, 8g. plain	12 15 0
Billets, soft	4 17 6 to 5 7 6
Billets, hard	6 12 6
Sheet bars	4 15 0 to 5 5 0
Tin bars	4 15 0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16½d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. Clifford & Son, Limited.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	13.84
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.39
Bessemer	16.89
Malleable	16.39
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	43.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Steel hoops	1.55
Sheets, black, No. 24	2.10
Sheets, galv., No. 24	2.75
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22 6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	12/- to 12/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	15/9 to 16/-
„	28×20 „	31/6 to 32/-
„	20×10 „	23/6 to 24/-
„	18½×14 „	16/3 to 16/6
C.W.	20×14 „	13/- to 14/-
„	28×20 „	—
„	20×10 „	—
„	18½×14 „	—

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 10 0 to £17 0 0
Bars and nail-rods, rolled, basis	£15 17 6 to £16 5 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£32 0 0 to £33 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.		
Sept.	15 ..	33	5	0	dec.	2/6
,,	16 ..	34	0	0	inc.	15/-
,,	19 ..	32	13	9	dec.	26/3
,,	20 ..	32	17	6	inc.	3/9
,,	21 ..	34	15	0	,,	37/6

Electrolytic Copper.

		£	s.	d.		
Sept.	15 ..	37	0	0	No change	
,,	16 ..	37	15	0	inc.	15/-
,,	19 ..	37	5	0	dec.	10/-
,,	20 ..	37	5	0	No change	
,,	21 ..	38	0	0	inc.	15/-

Standard Tin (cash).

		£	s.	d.		
Sept.	15 ..	149	10	0	dec.	42/6
,,	16 ..	151	12	6	inc.	42/6
,,	19 ..	147	2	6	dec.	90/-
,,	20 ..	149	10	0	inc.	47/6
,,	21 ..	151	15	0	,,	45/-

Tin (English ingots).

		£	s.	d.		
Sept.	15 ..	151	10	0	dec.	20/-
,,	16 ..	153	10	0	inc.	40/-
,,	19 ..	149	0	0	dec.	90/-
,,	20 ..	151	10	0	inc.	50/-
,,	21 ..	153	15	0	,,	45/-

Spelter (ordinary).

		£	s.	d.		
Sept.	15 ..	14	15	0	dec.	1/3
,,	16 ..	15	5	0	inc.	10/-
,,	19 ..	15	0	0	dec.	5/-
,,	20 ..	15	5	0	inc.	5/-
,,	21 ..	15	7	6	,,	2/6

Spelter (Electro, 99.9 per cent.).

		£	s.	d.		
Sept.	15 ..	17	2	6	dec.	2/6
,,	16 ..	17	15	0	inc.	12/6
,,	19 ..	17	5	0	dec.	10/-
,,	20 ..	17	10	0	inc.	5/-
,,	21 ..	17	10	0	No change	

Zinc Sheets (English).

		£	s.	d.		
Sept.	15 ..	24	0	0	No change	
,,	16 ..	24	0	0	,,	,,
,,	19 ..	24	0	0	,,	,,
,,	20 ..	24	10	0	inc.	10/-
,,	21 ..	24	10	0	No change	

Lead (English).

		£	s.	d.		
Sept.	15 ..	14	10	0	No change	
,,	16 ..	14	15	0	inc.	5/-
,,	19 ..	14	10	0	dec.	5/-
,,	20 ..	14	10	0	No change	
,,	21 ..	14	10	0	,,	,,

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	5 7 6	5 7 6	5 7 6	5 5 0	5 0 0	5 0 0	5 2 6	5 2 6	5 2 6	5 2 6	5 0 0	5 0 0	5 3 5½
1898	5 5 0	5 5 0	5 5 0	5 7 6	5 13 9	5 15 0	5 15 0	5 15 0	5 17 6	6 0 0	6 5 0	6 7 6	5 14 3
1899	6 10 0	6 12 6	6 15 0	6 15 0	6 17 6	6 17 6	7 0 0	7 0 0	7 5 0	7 5 0	7 12 6	7 15 0	7 0 5
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 2
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	19 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 2 6	7 3 4	7 2 6	7 3 9	7 7 6	7 8 5½	7 9 0	7 12 6	7 16 2	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	—	—	—	—	—

WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG

IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

SMALL ADVERTISEMENTS.

Notice.

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED.

BRASS FOUNDRY FOREMAN desires position; experienced in Admiralty contracts, gunmetal, phos. bronze and manganese castings; 12 years foreman in last situation.—Box 258, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

CHEMIST (23), disengaged, desires position in laboratory or foundry, competent analysis, and supervision of melting, mixing, casting all classes non-ferrous alloys; 7 years' experience with well-known Admiralty contractors.—MOSSMAN, 635, Foxhall Road, Ipswich.

FOUNDRY Foreman desires position, experience all classes Engineering and Jobbing work, iron and non-ferrous; thorough knowledge of metallurgy and mixing of metals; expert on cupola; take entire charge.—Box 260, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

REPRESENTATIVES required, on commission and expenses, for the sale of an absolutely necessary chemical to non-ferrous metal foundries in Great Britain.—Only those fully acquainted with trade should apply to Box 262, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

EMPLOYMENT REGISTER.

Conducted by the Institute of British Foundrymen by courtesy of the proprietors of THE FOUNDRY TRADE JOURNAL.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

POSITION required as Foundry Metallurgist or foundry executive position. Sound practical experience moulding, core-making, cupola and pattern shop. Good technical and commercial training. (191)

POSITION required as Foreman or Assistant Foreman, by young Moulder with good experience in general Engineering Foundries, including Iron, Steel, Malleable and Non-ferrous. City and Guilds Diploma. (192)

MACHINERY.

FOR Sale, one MacDonald No. 24 Jarr Moulding Machine with table 7 ft. 6 in. square.—Apply, JAMES W. ELLIS & COMPANY, LIMITED, 9, Ellison Place, Newcastle-upon-Tyne.

MACHINERY—*Continued.*

WEIGHING MACHINES.
3-cwt. Avery Portable Platform, £9.
5-cwt. Avery ditto, Type 282, as new, £14.
12-cwt. Pooley ditto, £15.
20-cwt. Pooley, dormant type, £18.
2-ton Denison-type Crane Weigher, £14.
10-ton Denison-type Crane Weigher, £22.
15-ton Denison-type Crane Weigher, £28.
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